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1 INTRODUCTION

1.1 Intended use of the ventilator

The PV 401-2 is a pressure-controlled, pressure-monitored ventilator, especially developed for treatment in the home of patients with chronic breathing difficulties. The PV 401-2 may be used for total life support on condition that either an external battery and/or an internal backup battery pack is installed as an extra backup supply should the mains supply fail or be disconnected.

The PV 401-2 is designed to give many years of trouble-free breathing assistance to the user provided that preventive maintenance is done at the specified intervals described in this manual. The service intervals vary due to the type of operation for which the ventilator is used.

Well-performed maintenance services will increase service life of the ventilator considerably. It is also important that any peripheral equipment is checked at the time the service is carried out.

1.2 Design and function of the ventilator

The PV 401-2 is constructed around a bellows which is driven by a ball screw assembly. An electronically-controlled servo-motor rotates the ball screw via a belt transmission, thus moving the bellows up or down. A microprocessor controls the correct speed of the motor and its power supply by means of calculations based on the settings for pressure, rate, inspiration time etc. The pressure and trigger settings are monitored at the same time.

In the event of a mains power failure, the ventilator will automatically switch to the external battery supply (if installed). Should this not be available, it will switch to the internal battery supply (if installed). This power source being used is indicated in the LCD display. If the external battery voltage drops too low, an audible alarm is given.

1.3 The scope of this manual

All routine maintenance checks and additional service actions for the PV 401-2 are described in this manual. The manual contains all documentation required for maintenance and service, such as replacement parts lists, exploded drawings, wiring diagrams, component location guides, etc.

Breas Medical reserves the right to make changes to the product and the contents of this manual without prior notice.

1.4 Intended audience

This Service Manual is intended for technicians who have medical/technical training and knowledge of the construction and function of the ventilator.

It is not intended for clinic personnel or patients.

1.5 Service personnel's training requirements

Thanks to the simple construction of the PV 401-2, no special competence other than general medical technical training on ventilators is required.

Always contact BREAS MEDICAL if there are any questions or if training is required.

All service must, however, be performed as described in this manual.

3 MAINTENANCE SERVICE INSTRUCTIONS

All routine maintenance checks and additional service instructions for the PV 401-2 are described in this chapter. For information about fault-tracing, detailed drawings, board schematics, spare parts etc, please refer to the respective chapter in this Service Manual.

A Patient Instruction manual is supplied with the ventilator and the checks described there should be followed by the patient and/or care providers.

Before starting the maintenance service, read the Special Safety Precautions section and have a new Service Record (photocopy the example in the Appendices chapter) and all the necessary equipment, tools and replacement parts at hand.

3.1 Verifying the components and software installed

Check the Engineering Change History in the Appendices for a history of changes made, and from which serial number they were implemented.

If in any doubt, read the component designation on circuit boards and PROMs, as upgrades may have been made which have not been recorded in the Engineering Change History.

3.2 Special safety precautions

- Do not work on the ventilator with the casing removed and the power supply connected.
- Explosive gases and fluids must not be used near the ventilator.
- Take all necessary ESD precautions.

3.3 Equipment and tools required

A test lung or reservoir bag.

A measuring instrument for tidal volume and minute volume/rate (Biotek Ventilator tester, Timeter, Spirometer or equivalent).

A universal instrument.

A standard toolkit containing screwdrivers, Allen keys, Torx keys and sockets.

A new Service Record (photocopy the Service Record in the Appendices section of this binder).

3.4 Replacement parts required

The following parts should be available when servicing.

Part No.	Description
204020	Patient circuit
215090	Service kit incl. membranes, 0-rings for check valves and drive belt
205180	Membrane assembly for exhalation valve
285911	Grease (BREAS 240 AC)
1445	Air filter, patient air, washable
1428	Air filter, patient air, disposable
If required:	
215100	Internal battery kit
205680	Battery for alarm (Ni-Cd)
205490	Motor Unit Kit for replacement at 20,000 operating hours

3.5 Maintenance service instructions

The maintenance service comprises the checks listed in the table below. The reference numbers stated refer to the Chapter and Section in this manual where detailed instructions can be found.

3.6 Service schedule

IMPORTANT!
A complete maintenance service (as described in this chapter) must be done every 12th month. If the ventilator is used for continuous operation (24 hours per day) a complete maintenance service must be done every 6th month.

Every 12th month, or every 6th month if the ventilator is used for continuous operation (24 hours per day).	**See Ch./ Section No.**
Motor Unit	
Change drive belt	7.3
Lubricate ballscrew	7.4
Change check valve membranes and O-rings	7.5
Leakage test of motor unit and tubes	7.6
Electronics	
Calibrate pressure sensor	8.5
Check operation using internal battery (where applicable)	8.6
Check operation using external battery (where applicable)	8.7
Check electrical safety levels	8.11
Accessories (where applicable)	
Inspect patient circuit	2
Change membrane in exhalation valve	3.9.10
Clean PEEP adapter, change O-ring	3.9.10
Every 24 months	
Replace the internal battery pack	6.5
Every 5th year	
Change alarm batteries	8.8
Every 20,000 operating hours	
Change the complete motor unit	6.13

3.6.1 Open a new Service Record, identify and register the ventilator

- Make a copy of the Service Record in the Appendices chapter.
- Fill out the model, serial number and any inventory number on the Service Record.
- Check any comments recorded on previous Service Records.
- Document the current patient settings.

3.6.2 Additional Services Required

- Check the number of operating hours and enter it on the service record.
- Check the service schedule to see whether the alarm batteries, internal battery kit or the complete motor unit are due to be replaced.

3.6.3 Markings

Make sure that all markings on labels can be read:

- Make, model description, serial number.
- Warning texts.
- Any inventory markings.
- All other texts etc.

3.6.4 Information from the user

Check the following with the patient:

- Has the function of the ventilator been trouble-free? If not, what problems have there been?
- How does the patient check the function of the ventilator? How often?
- How often has the filter been replaced?
- What filters will the patient need to last until the next service?
- Other observations?

3.6.5 Validity of the technical documentation

- Check the validity of the patient instructions.
- Check if any modification or upgrading of the ventilator needs to be done at the same time as the service.

3.7 External checks

3.7.1 Visual inspection for external damage and wear

- Clean the outside using window-cleaning fluid.
- Check for any visible damage to the casings and other components.
- Check that nothing has worked loose (including the handle).

3.7.2 Power connection

- Check the plugs on the power cable, the cable itself and the ventilator's power socket.
- Make sure that the strain relief clamp for the power cord is not damaged.
- Inspect the external battery cable, if used.
- Check the external battery socket in the ventilator.

3.7.3 Minimum function check

- Connect the power cord.
- Connect the patient circuit.
- Switch on the ventilator and make sure it operates normally.

3.8 Internal checks

3.8.1 Cleaning

- Remove the casing. See Chapter 6 Dismantling and Assembling the PV 401-2 for instructions.
- Remove any dirt or dust that has collected in the ventilator.

3.8.2 Cabling

- Inspect all cables and their connectors. Check the front and rear panels to make sure that cables and wires are not pinched.
- Change any cable strap anchor that has become loose.

3.8.3 Fastening of components

- Make sure that all components, such as the motor, printed circuit boards, connectors, etc are securely fastened.

3.8.4 Replace drive belt

- Refer to section 7.3 for information.

3.8.5 Lubricate ballscrew

- Refer to section 7.4 for information.

3.8.6 Replace membrane assemblies in check valves

- Refer to section 7.5 for information.

3.8.7 Power supply

- Make sure that the power socket is undamaged and is securely in place.
- Make sure that the touch-protection is undamaged and properly tensioned over the socket.
- Make sure the transformer is securely fastened.
- Check the wiring to and from the transformer.

3.8.8 Calibrate the pressure sensors

- Refer to Chapter 8.5 for information.

3.8.9 Reassemble the casing

- Refer to Chapter 6 for instructions.

3.8.10 Electrical Safety

- Refer to Chapter 8.11 for information.

3.8.11 Leakage test of tubes and bellows

- Refer to Chapter 7.6 for information.

3.9 Final checks before handing over

3.9.1 Function check

- Connect the patient circuit, start the ventilator and check that everything works normally.

3.9.2 Check low pressure/leakage alarm

- Set the pressure to 20 mbar.
- Create a leakage so that a pressure of 20mbar cannot be reached.
- Check that the alarm LED for PRESSURE lights and that an audible alarm is given.

3.9.3 Check low volume alarm

- Set the low volume limit to a value less than the volume of the test lung/reservoir bag.
- Check that the alarm LED for VOLUME lights and that an audible alarm is given.

3.9.4 Alarm mute

- Switch on the ventilator. Do not connect anything to the patient air connection. Wait 15 seconds for the "VOLUME" alarm to be activated. Press the mute button and make sure the signal is muted. Make sure the signal is comes on again after approximately 2 minutes.

3.9.5 Trigger

- Set the trigger to -0.5 mbar.
- Create a negative pressure and make sure a triggered breath is given. The green LED for Insp. Trig. should light.

3.9.6 Checking the pressure/rate

- Adjust the settings to:

  Pressure: 20 mbar
  Rate: 10 BPM
  Insp: 3.0 sec
  Mode: PCV

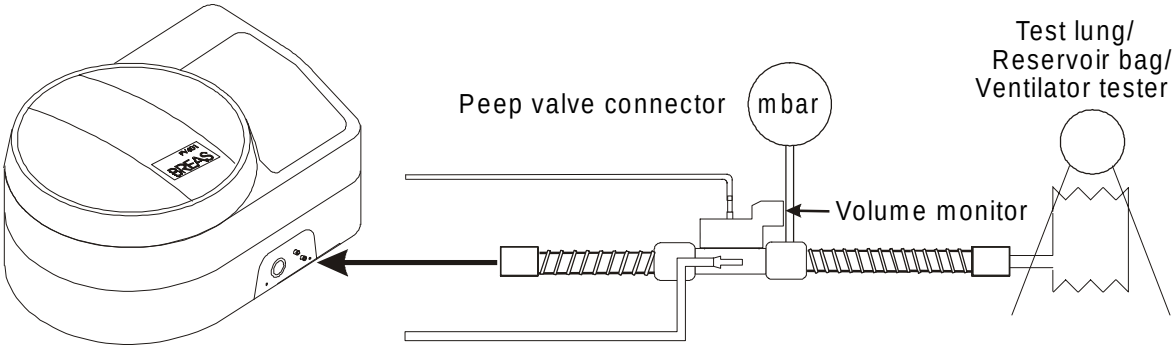


Fig. 3-1 Checking pressure and rate

- Measure and check that the pressure, rate and insp. time are correct, (accuracy ± 10%). The measuring should be done with a test lung or a reservoir bag connected. (If these are not available, block the exhalation valve in the patient circuit.)

3.9.7 Checking the tidal volume indication

If a ventilator tester Biotek VT-1 or 2 is used, the estimated tidal volume can be tested as follows:

- Set the compliance of the test lung to 0.02 L/cm H_2O
- Select volume measuring
- Set the PV 401-2 as follows:

  Pressure: 30 mbar
  Rate: 8 BPM
  Insp: 5.0 sec
  Mode: PCV

When checking using a volume monitor, an exhalation valve with a PEEP valve connector is required. The volume monitor is then connected to the PEEP valve outlet on the exhalation valve outlet.

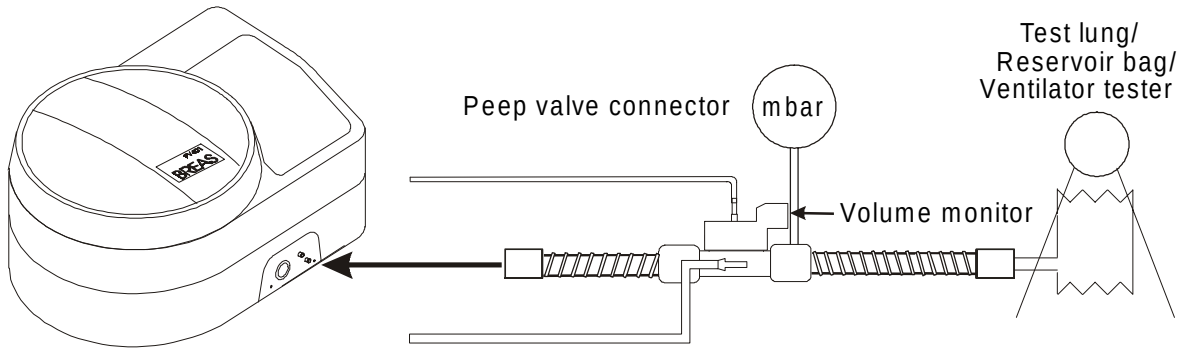


Fig. 3-2 Checking tidal volume

- Check the accuracy (± 20%).

3.9.8 External battery operation

- Connect an external battery.
- Disconnect the power cord while the ventilator is running.
- Check that the ventilator automatically switches over to external battery operation.The following indications should be given:
  - an audible alarm (not if there is an internal battery installed)
  - the LED in the ON/OFF button should start to flash
  - the letter E should be displayed in the POWER field.
- Reconnect the power cord and make sure that the LED in the ON/OFF button shows a steady light, the audible alarm stops and the letter M is displayed in the POWER field.

3.9.9 Internal battery operation

- Disconnect any external battery.
- Disconnect the power cord while the ventilator is running.
- Check that the ventilator automatically switches over to internal battery operation. The following indications should be given:
  - an audible alarm
  - the LED in the ON/OFF button should start to flash
  - the letter E should be displayed in the POWER field.
- Reconnect the power cord and make sure that the LED in the ON/OFF button shows a steady light, the audible alarm stops and the letter M is displayed in the POWER field.

3.9.10 Checking accessories

Patient circuit

- Inspect the patient circuit and change if necessary.

Changing the membrane in the exhalation valve

This instruction applies to BREAS exhalation valves (see figure below).

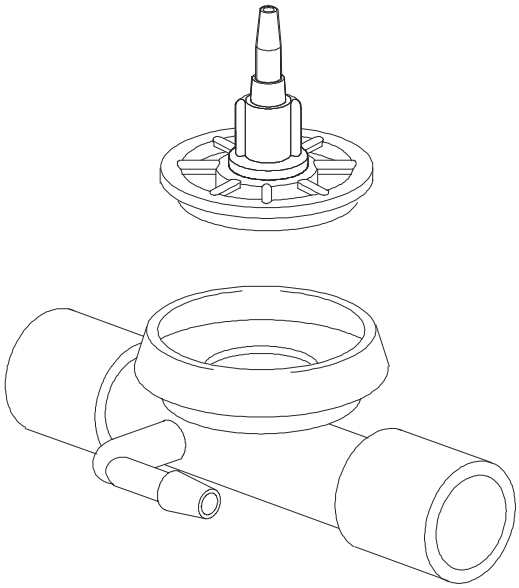


Fig. 3-3 Breas exhalation valve

- Remove the PEEP adapter, if fitted, see Cleaning the PEEP adapter.
- Unscrew the complete membrane assembly, see fig.3-3.
- If a PEEP adapter is installed, take care of the O-ring seal.
- Clean the inside of the exhalation valve using a moist rag (Clean according to local regulations).
- Screw on the new membrane assembly.
- If a PEEP valve is to be used, fit the O-ring seal for the PEEP valve, as shown in the bottom figure on the next page.
- Connect the exhalation valve to a test lung. Check that no leakage occurs during the exhalation phase.

Cleaning the PEEP adapter

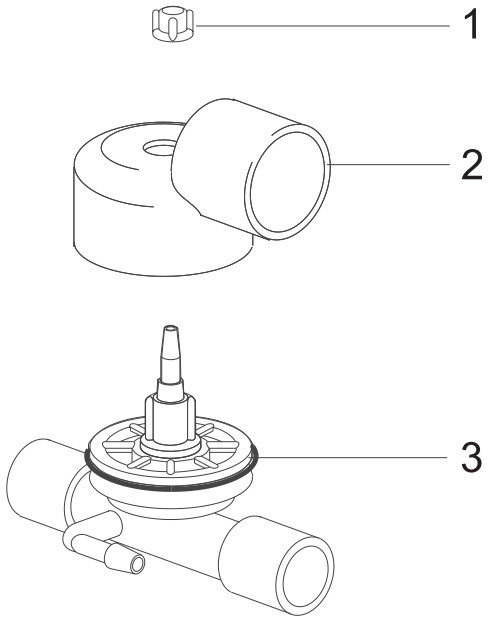


Fig. 3-4 Peep adapter

- Remove the plastic nut (1) holding the PEEP adapter.
- Pull the adapter (2) up from the exhalation valve. Do not remove the O-ring (3).
- Clean using a moist rag (Clean according to local regulations).
- Check that the O-ring seal is still properly in place. If not, fit it to the exhalation valve as shown in figure 3-5. Do **not** fit the O-ring to the exhalation valve cover before screwing it on.

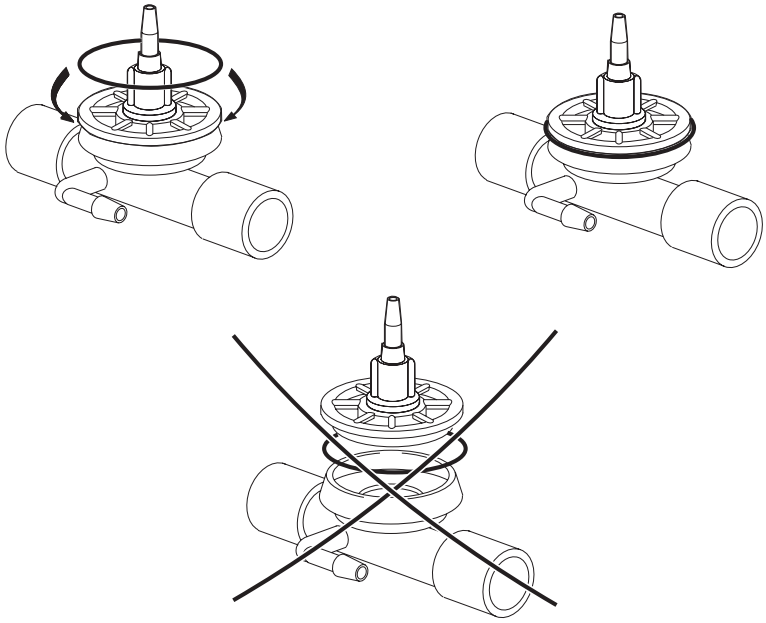


Fig. 3-5 Fitting O-ring to exhalation valve

- Fit the PEEP adapter to the exhalation valve and screw on the plastic nut.

Check any other accessories.

3.9.11 Change/wash patient filters

- Change the white air filter. Make sure that the patient has a supply of filters to last to the next service point.
- Wash or change the grey filter if necessary.

3.9.12 Adjust the settings for the patient

- Adjust the settings as prescribed for the patient.

4 REPLACEMENT PARTS

4.1 General view

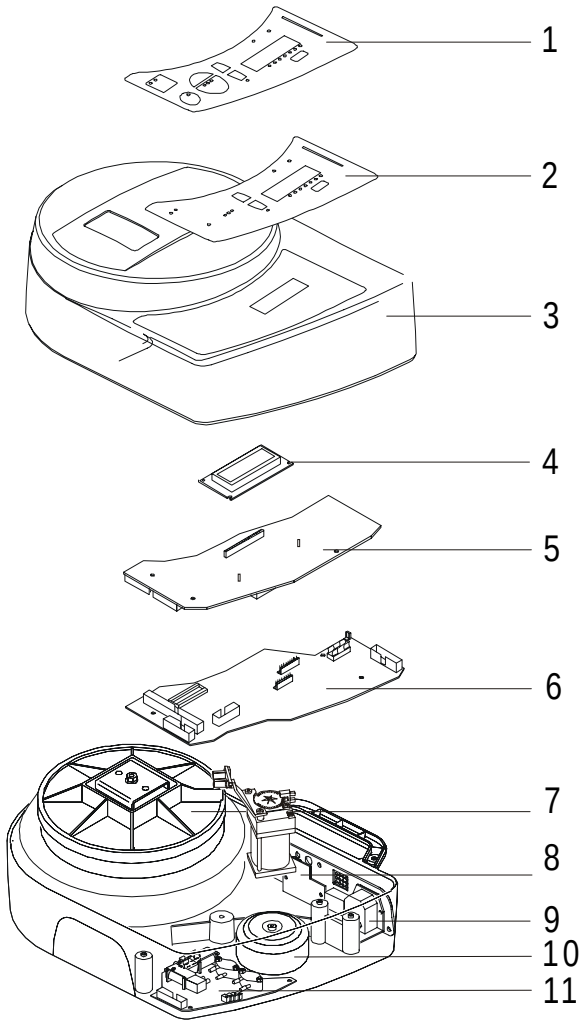
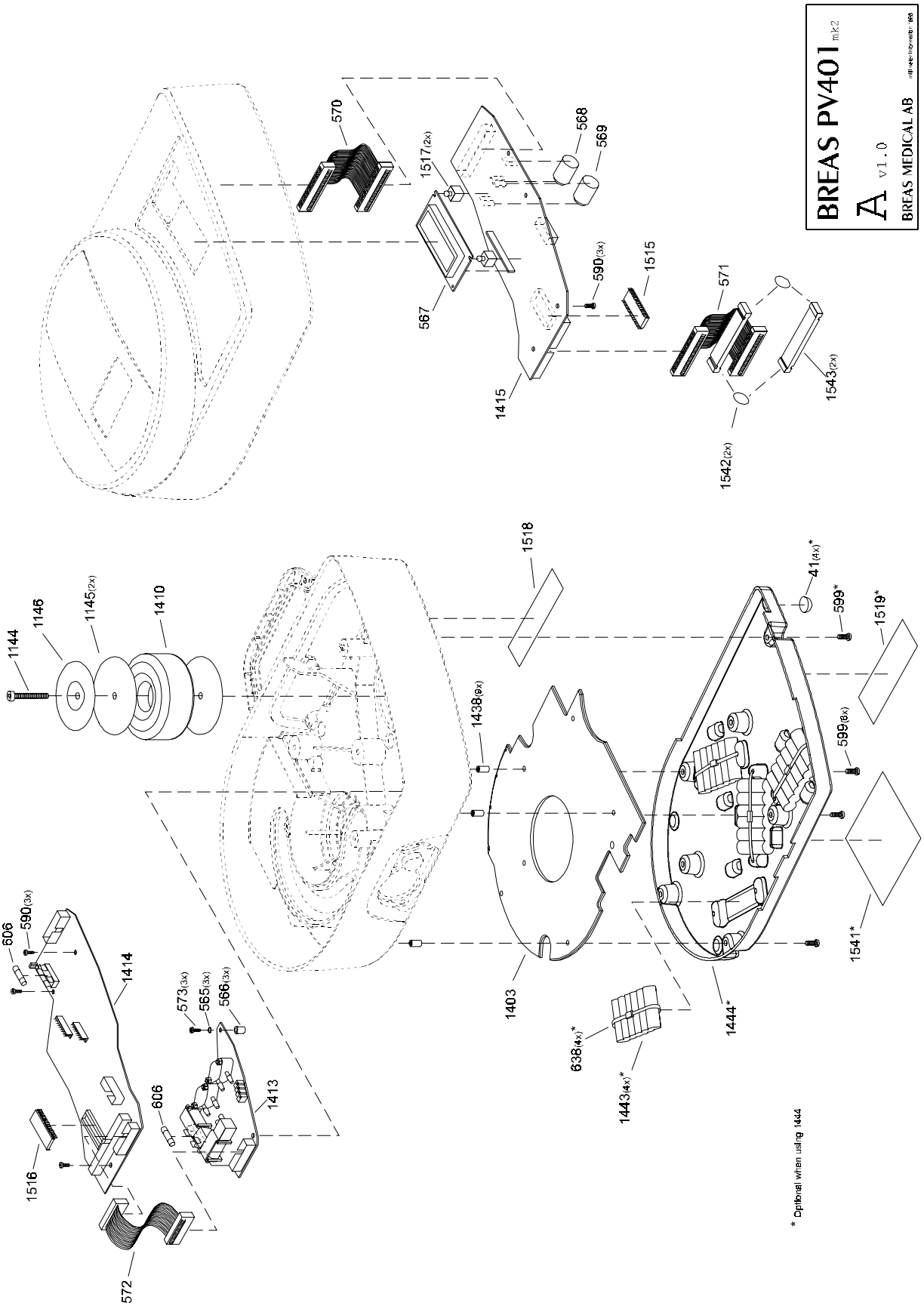


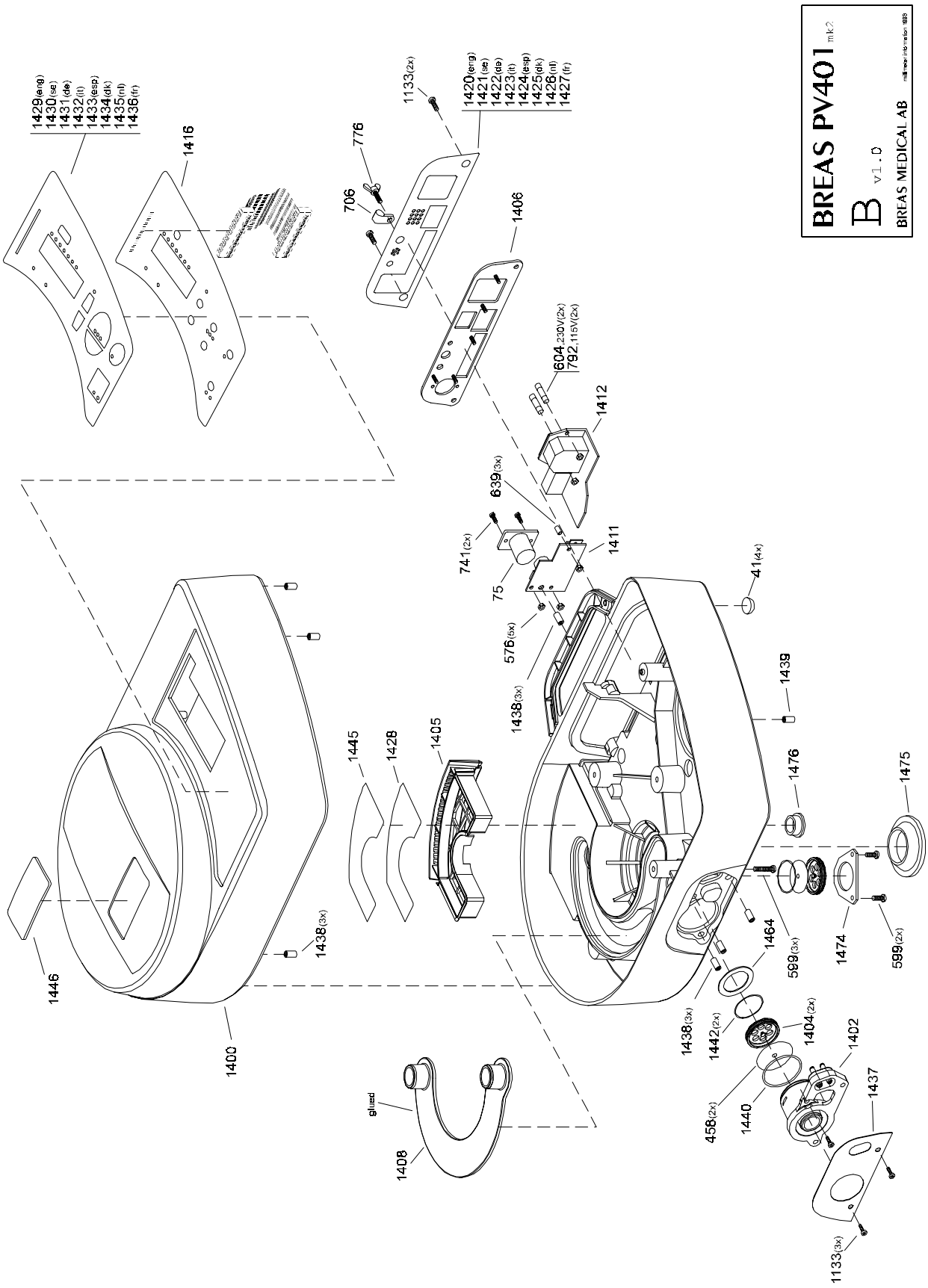
Fig. 4-1 PV401-2, Main components

Pos.	Description
1	Panel decal
2	Membrane pushbutton pad
3	Upper casing
4	LCD display
5	CPU board
6	MDA board
7	Motor unit, complete (also available as exchange unit, part No. 205680)
8	I/O board
9	MFC board
10	Transformer
11	PGC board

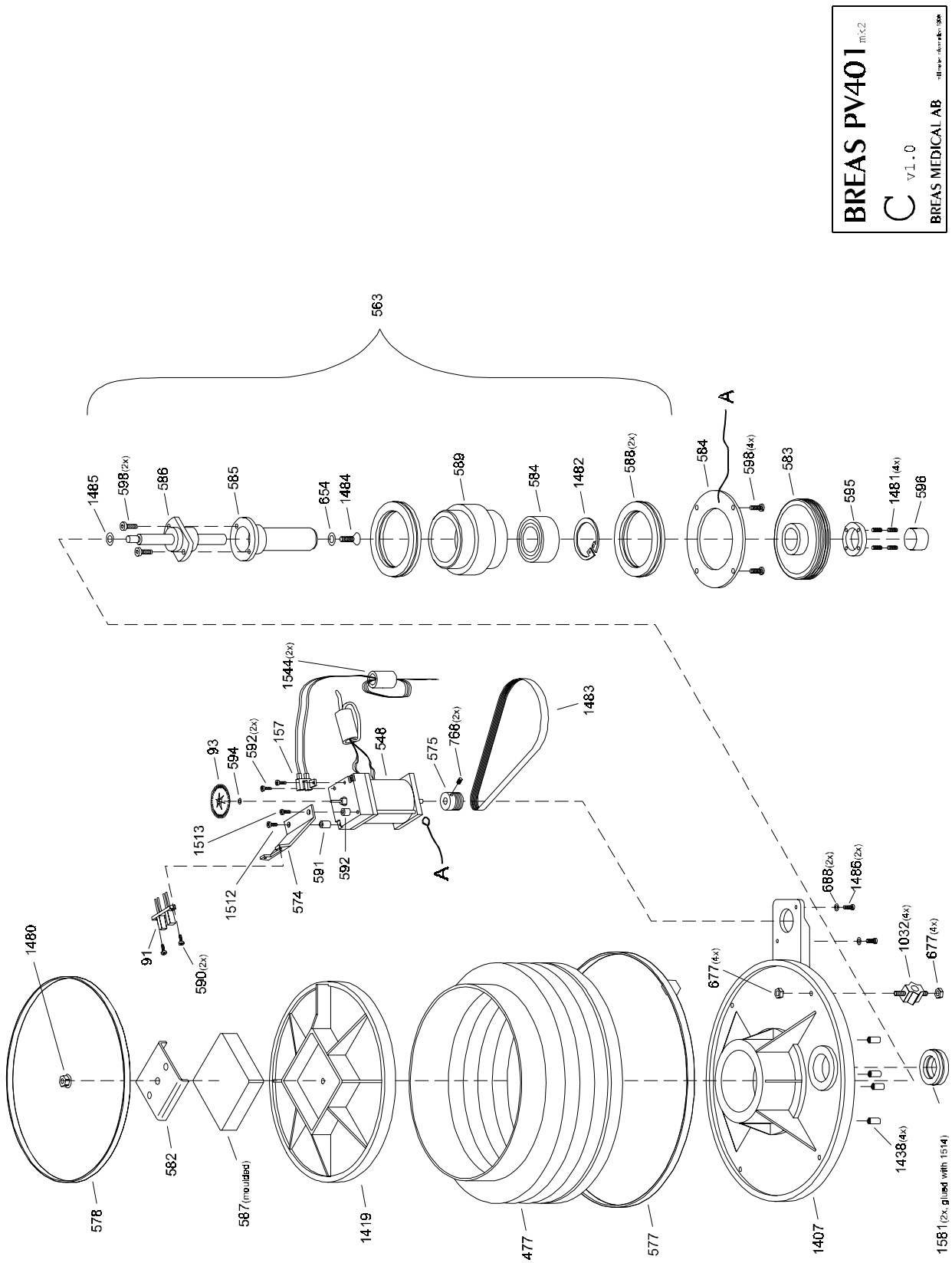
4.2 Parts drawing - Motor, Circuit Boards and Transformer



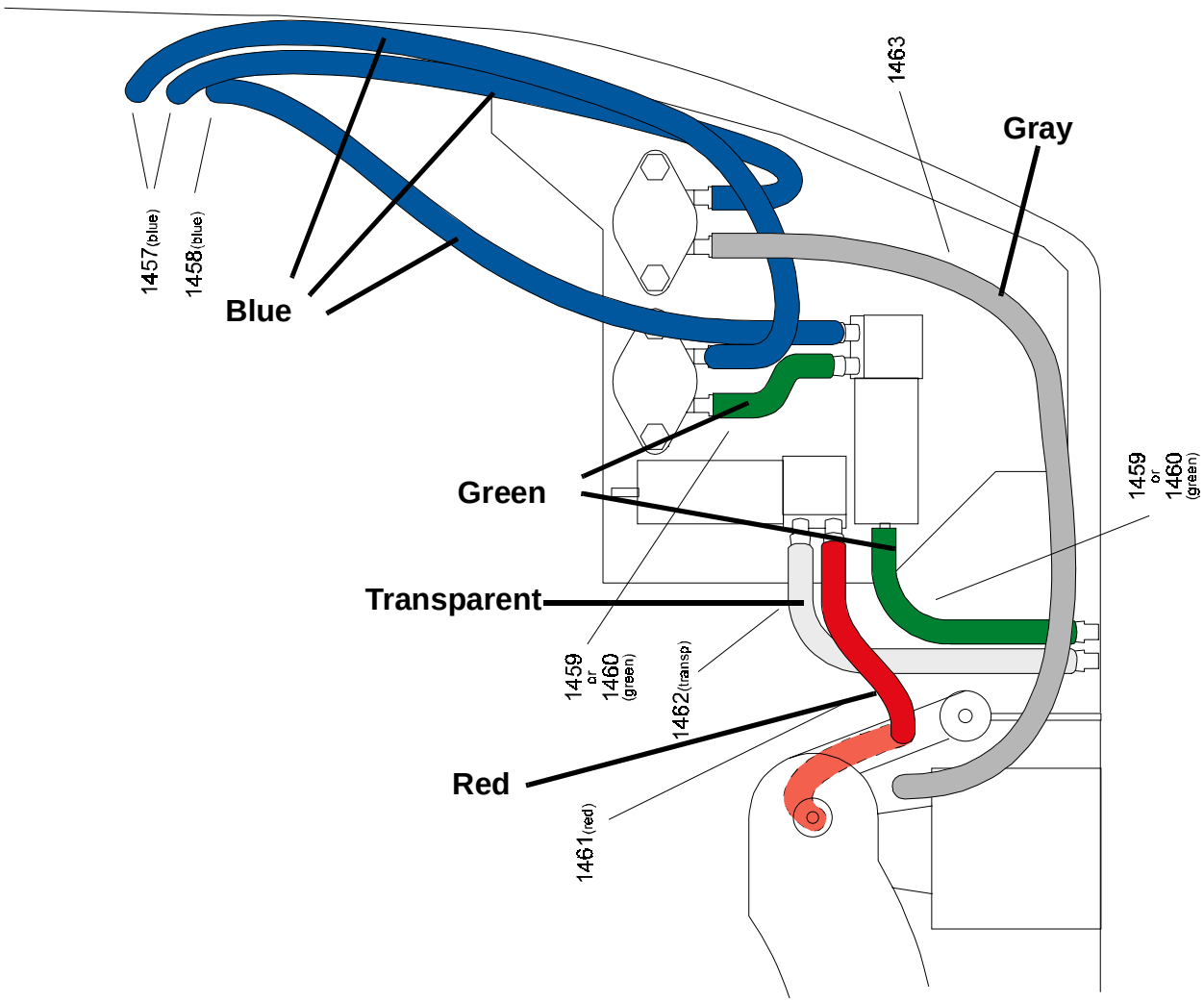
4.3 Parts drawing - Casings, Panels, Decals, Valves and Filters



4.4 Parts drawing - Motor Unit



4.5 Tubes and connections



4.6 List of replacement parts

Part No.	Description
32	Pressure sensor
41	Rubber mount - vibration absorbent (motor)
75	Chassis pin device
109	Magnetic valve
458	Membrane, check valve PV 401
477	Bellows (mkII) PV 401-2
548	Motor (PV401-2)
549	Motor Unit PV401-2 complete
563	Motor Unit PV 401-2 Exchange unit
565	O-ring 3x3 nbr70 (fastening of tg-board)
566	Tube2,5x6 blue 6 mm length (cut from part No. 1054)
567	Display LCD (powertip) for 401-2 with soldered-on pin strip
568	Alarm battery 4,8 V Ni-MH 70 mAh l=25mm dia=17mm
569	Battery for internal memory 3 V Lithium mAh l=25mm dia=17mm
570	Ribbon cable 40 pole with IDC l=100mm (CPU-Overlay)
571	Ribbon cable 50 pole with IDC connector l=100mm (CPU-MDA)
572	Ribbon cable 20 pole with IDC connector l=60mm (CPU-TG)
573	Screw RTX FXST 2,9 x 16 Fzb
574	Fastening bracket for opto-switch (Scanac no 1654)
575	Pulley wheel motor poly-V PV401-2 (Scanac no.1653)
576	Nut M3 nyloc
577	Bellows clamp, steel 325 mm 401-2 lower
578	Bellows clamp, steel 215 mm 401-2 upper
581	Sealing ring, air tube, white silicon (Scanac no. 1656)
582	Fastening plate for moving bellows end cover PV401-2
583	Pulley wheel large poly-V PV401-2 (Scanac no.1674)
584	Flange
585	Shaft
586	Ballscrew with nut
587	Polyurethane elastomer (Swedac U-16 soft end cover PV401-2)
588	Sealing ring, bearing, white silicon (Scanac No. 1657)
589	Bearing sleeve
590	Screw RTK 2,9x9,5 fzb
591	Spacer piece DRM 4380x12
592	Spacer piece DRM 4380x10
593	Screw MRT 3x8 fzb
594	Washer 2,7x6x0,5 DIN 125
595	Cover nut
596	Threaded cover
597	Ball bearing, twin race angled contact bearing
598	Screw MRT 4x10 fzb

599	Screw MRT 4x10 black-chromate
604	Fuse - T 315mA
606	Fuse - F 3,15A
641	Blue Festotube
654	Washer - M6 - flat washer BRB 6,4fzb
677	Nut - M6M steel M4 NV7*3,2 FZB
706	Strain relief for cable, mains
776	Screw- VS steel M4*12 FZB
792	Fuse, 630mA
1032	LF-isolator
1133	Screw MRT 4x14 black-chromate
1144	Screw MRX-Z 5x35 fzb
1145	Washer rubber for transformer
1146	Washer, metal for transformer
1148	Screw Phillips UNC thread for motor "Pittman 401-2" approx. 20mm
1149	Screw Phillips UNC thread for motor "Pittman 401-2" approx. 15mm
1400	Casing upper
1401	Casing lower
1402	Outlet patient air
1403	Cover (over filter cassette)
1404	Valve - back seat
1405	Filter cassette
1406	Fastening plate rear panel
1407	Fixed end 401-2
1408	Cover (air channel
1409	Bellows 401-2
1410	Transformer
1411	Circuit board D-sub
1412	Circuit board Power inlet
1413	Circuit board Magnetic valves
1414	Circuit board MDA
1415	Circuit board CPU
1416	Membrane pushbutton panel
1417	Drawing decal outlet
1418	Drawing decal fastening plate rear panel
1419	Moving bellows end cover mold-injected (Scanac no. 50145)
1420	Decal Rear panel ENG
1421	Decal Rear panel SE
1422	Decal Rear panel DE
1423	Decal Rear panel IT
1424	Decal Rear panel ESP
1425	Decal Rear panel DK
1426	Decal Rear panel NL
1427	Decal Rear panel FR

1428	Filter PV 401-2 mk2
1429	Decal - pushbutton panel/LCD SE
1430	Decal - pushbutton panel/LCD ENG
1431	Decal - pushbutton panel/LCD DE
1432	Decal - pushbutton panel/LCD IT
1433	Decal - pushbutton panel/LCD ESP
1434	Decal - pushbutton panel/LCD DK
1435	Decal - pushbutton panel/LCD NL
1436	Decal - pushbutton panel/LCD FR
1437	Decal - patient air outlet
1438	Screw- M4 insert threaded Spreadsert 1
1439	Screw- M5 insert threaded Spreadsert 1
1440	O-ring 37, 0*2,0 EPDM
1441	O-ring 35, 0*1,2 nitrile
1442	O-ring 28,0*1,3 EPDM
1443	Int.battery pack 20 pcs nimh with cable
1444	Casing for battery pack 401-2
1445	Filter - coarse (PPI 45)
1446	Logotype - polygloss panel
1447	Operating manual 401-2 SV
1448	Operating manual 401-2 ENG
1449	Operating manual 401-2 TY
1450	Operating manual 401-2 IT
1451	Operating manual 401-2 ESP
1452	Operating manual 401-2 DK
1453	Operating manual 401-2 NL
1454	Operating manual 401-2 FR
1455	Operating manual 401-2 NORSK
1456	Operating manual 401-2 FI
1457	Tube blue 2,5*6 190mm silicon
1458	Tube blue 2,5*6 125mm silicon
1459	Tube green 2,5*6 45mm silicon
1460	Tube green 2,5*6 45mm silicon
1461	Tube red 2,5*6 100mm silicon
1462	Tube neutral 2,5*6 65mm silicon
1463	Tube black 2,5*6 230mm silicon
1464	Seal silicon 35,5x25x1,0
1465	Circuit board - complete kit
1474	Lock washer for check valve PV402 (I-repro no. 6650)
1475	Bottom plug (Ulinco SR 1765 part no. 10517) for PV402
1476	Protective plug for internal battery connector
1477	D-sub protection for female25 pole
1480	Nut flange nut DIN 6923 M5
1481	Stop screw P655 4x5 fzb

1482	Groove ring SgH 47 seeger Fuse "dp 401-2"
1483	Poly V-belt 4-170H
1484	Screw MF6S 4x8 fzb
1485	Washer (aluminium from Warner electric,1675)
1486	Screw MRT 3x10 fzb
1510	Internal battery kit PV 401-2 (1443+1444)
1511	ScrewM4 Insert thread Non-locking for wing bolt in rear panel
1512	Screw 30 mm 5/32" (t mot. 548 for fastening of bracket 574)
1513	Screw 15 mm 5/32" (t mot. 548 for fastening of bracket 574)
1514	Glue silicon glue from Leewood for gluing 581
1515	Software CPU PV401-2 EPROM (27C256 programmed)
1516	Software MDA PV401-2 EPROM (27C256 programmed)
1517	Spacer 9,93mm Miniature distance bushing CBSTE-6-01A-RT
1518	Decal serial number (polyester 99x25mm)
1519	Decal ce marking mm (polyester 99x34mm)
1520	Casing upper complete (413,454,63,409-412)
1522	Rear panel complete with circuit boards and transformer includes (1406+1412+1411+75+1410)
1541	Decal with instructions för int. batt pack 401-2 (stuck on 515)
1542	O-ring 15x1,5 mm Holds together ferrite clamp 1543 in PV401-2
1543	Ferrite clamp on ribbon cable PV401-2
1544	Ferrite clamp on motor and sensor cables PV401-2

5 FUNCTIONAL DIAGRAMS

5.1 Pneumatic diagram

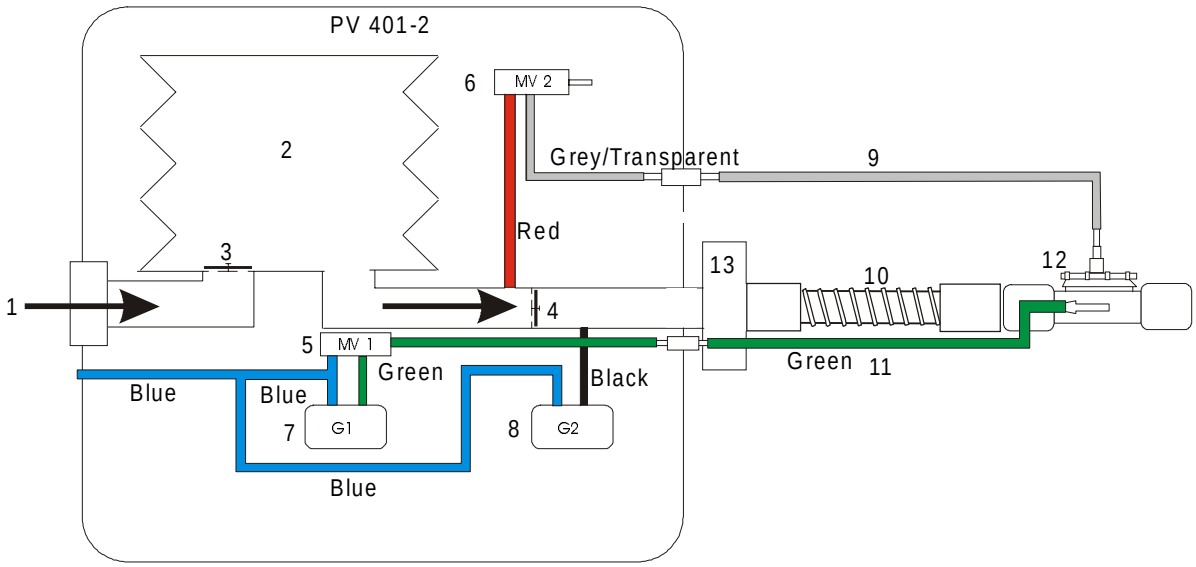
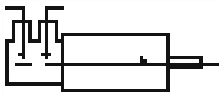


Fig. 5-1 Pneumatic drawing

1. Patient air inlet (through air filter)
2. Bellows
3. Check valve (closed during inspiration)
4. Check valve (closed during expiration)
5. Magnetic valve MV 1 (Normally set as in (1). Switches during autocalibration off G1 according to (2).)
6. Magnetic valve MV 2 (Normally set as in (2). Safety valve that switches at too high pressure according to (2).)
7. Pressure sensor G1
8. Pressure sensor G2
9. Control pressure tube for the expiration valve
10. Patient air tube
11. Tube for measuring the pressure
12. Expiration valve
13. Bacteria filter (if used)



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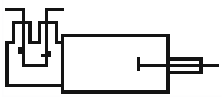

2

5.2 Functional block diagram

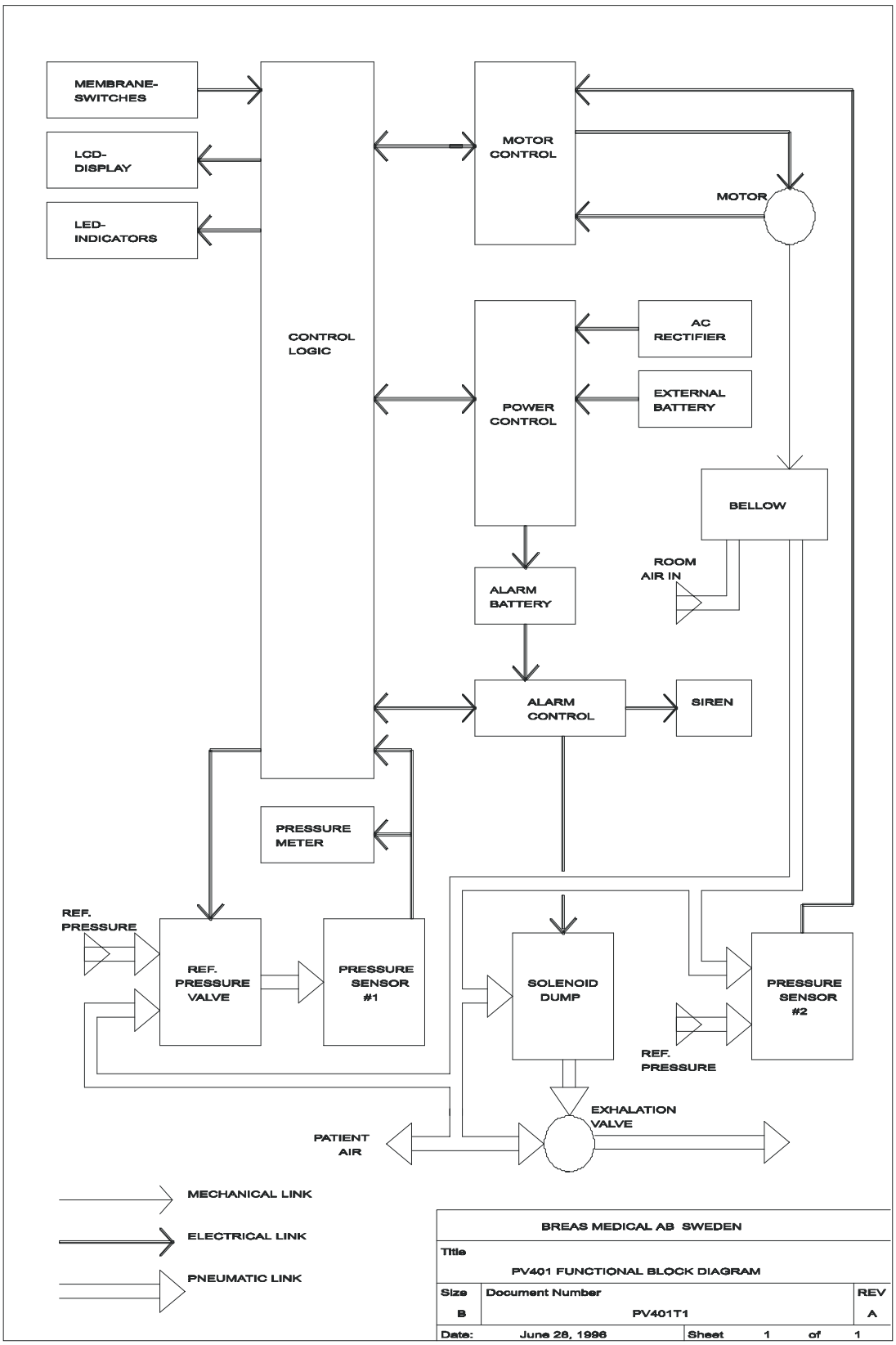

Fig. 8-2 Functional block diagram

6 REMOVING/REPLACING THE MAIN COMPONENTS

6.1 Removing the upper casing

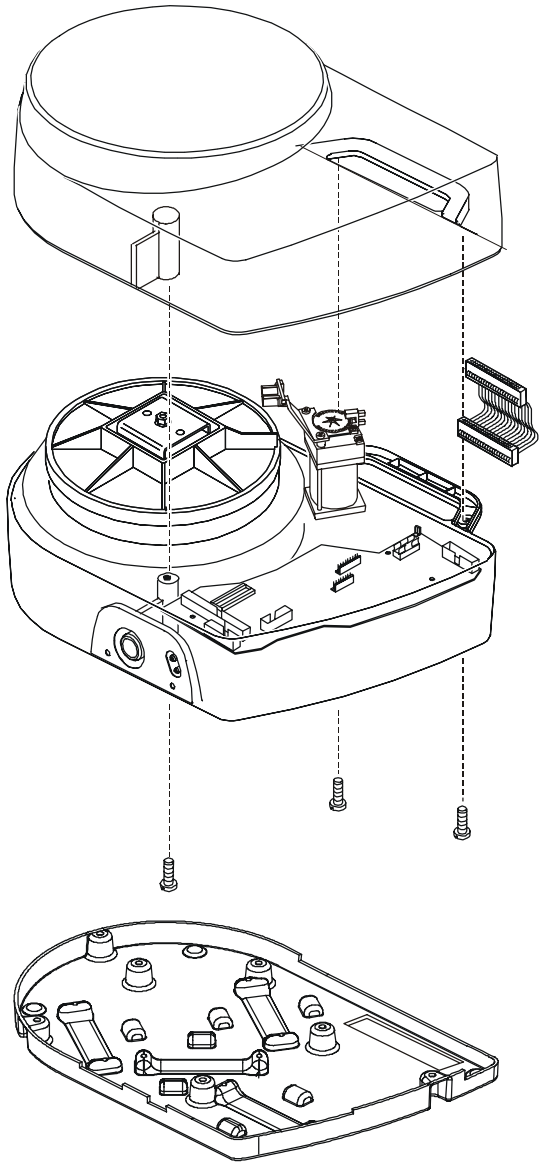

Fig. 6-1 Removing the upper casing

- Remove the power cord.
- Remove the two M4 screws (TX20 head) from under the carrying handle and the screw from underneath the ventilator at the front.
- Lift up the upper casing and disconnect the ribbon cable from the CPU board. Put the casing to one side.

6.2 Removing/replacing the pushbutton membrane panel

- Remove the upper casing (see Section 6.1).
- Remove the CPU board (see Section 6.3).
- If still connected, disconnect the ribbon cable from the CPU board.

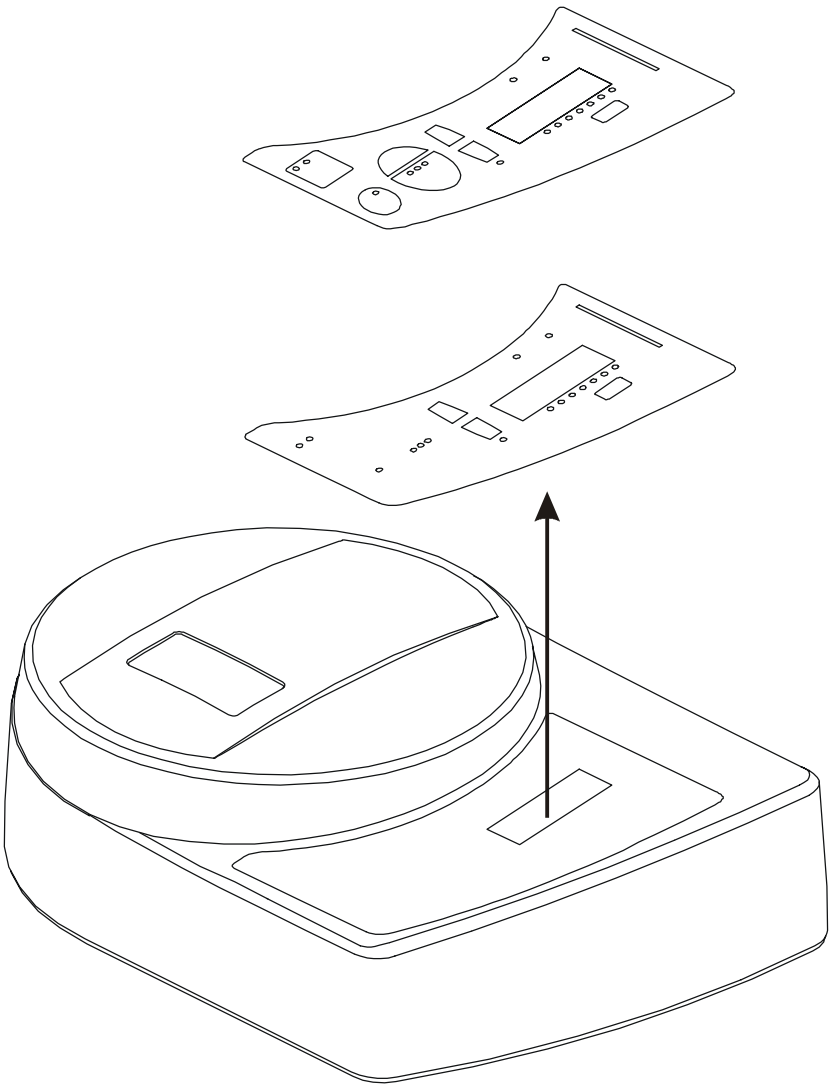

Fig. 6-2 Removing the decal and pushbutton board

- Start to loosen the pushbutton panel and decal as one unit by carefully prising it up from underneath the opening in the casing for the LCD display. Continue to carefully work the panel up until it can be removed.
- Reassemble in the reverse order.

6.3 Removing/replacing the CPU board

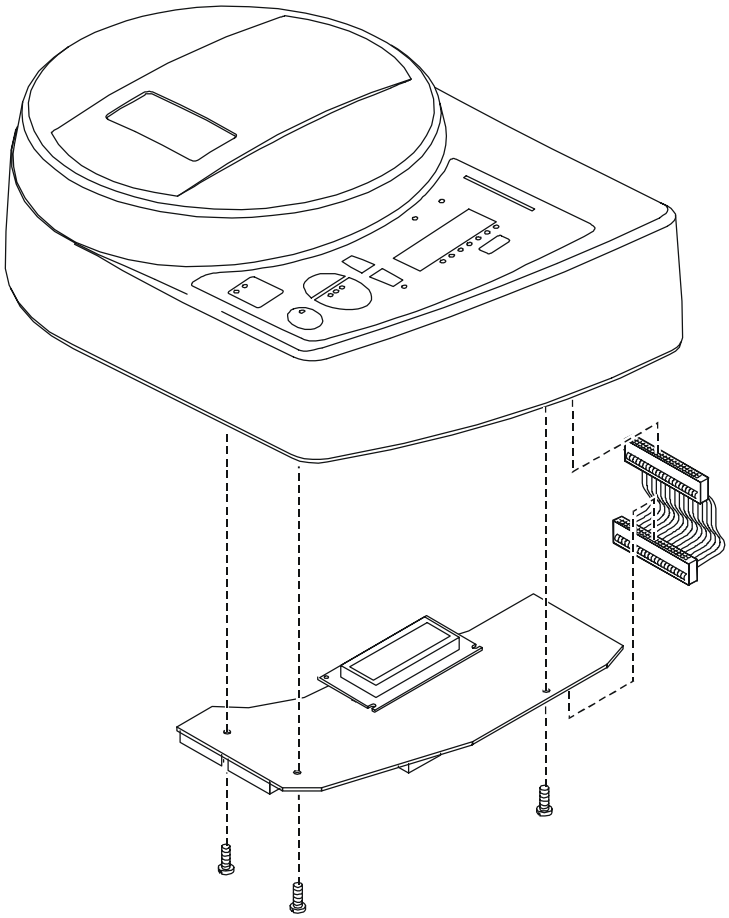

Fig. 6-3 Removing the CPU board from the upper casing

- Remove the upper casing (see Section 6.1).
- Disconnect the ribbon cable from the pushbutton membrane board.
- Remove the three screws holding the CPU board and remove the board.
- Loosen the LCD board from its strip connector and the two plastic supports.
- Reassemble the new board in the reverse order.

Important! When replacing the CPU board, the software must be programmed for if an internal battery is installed or not, and if the battery relay K2 is fitted on the MDA board or not. See “Programming the software” for more information.

6.4 Removing/replacing the MDA board

- Remove the upper casing (see Section 6.1).

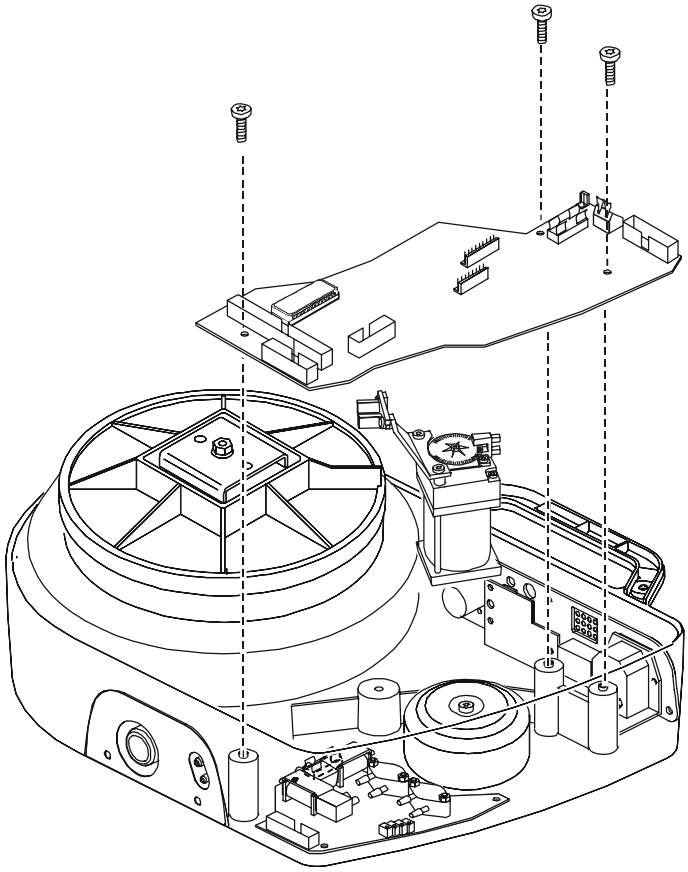

Fig. 6-4 Removing the MDA Board

- Disconnect all the ribbon cable connectors, the external battery connector from CN4, and the wires to the transformer.
- Remove the three screws that hold the MDA board.
- Lift out the MDA board.
- Reassemble the new board in the reverse order.

Important! When replacing the CPU board, the software must be programmed for if an internal battery is installed or not, and if the battery relay K2 is fitted on the MDA board or not. See “Programming the software” for more information.

6.4.1 Replacing the MDA board with revision G or higher

There is a switched 12V regulator which supplies the board with 12VDC. For MDA boards with revision G or later, there is a relay (K2), see figure, which switches the DC power between the internal battery (if installed) and the external battery input. The master processor on the CPU board must be programmed if the MDA board has this relay or not. This is done by using the setup menu provided by the master EPROM of version MAW or higher. See “Programming the software” for more information.

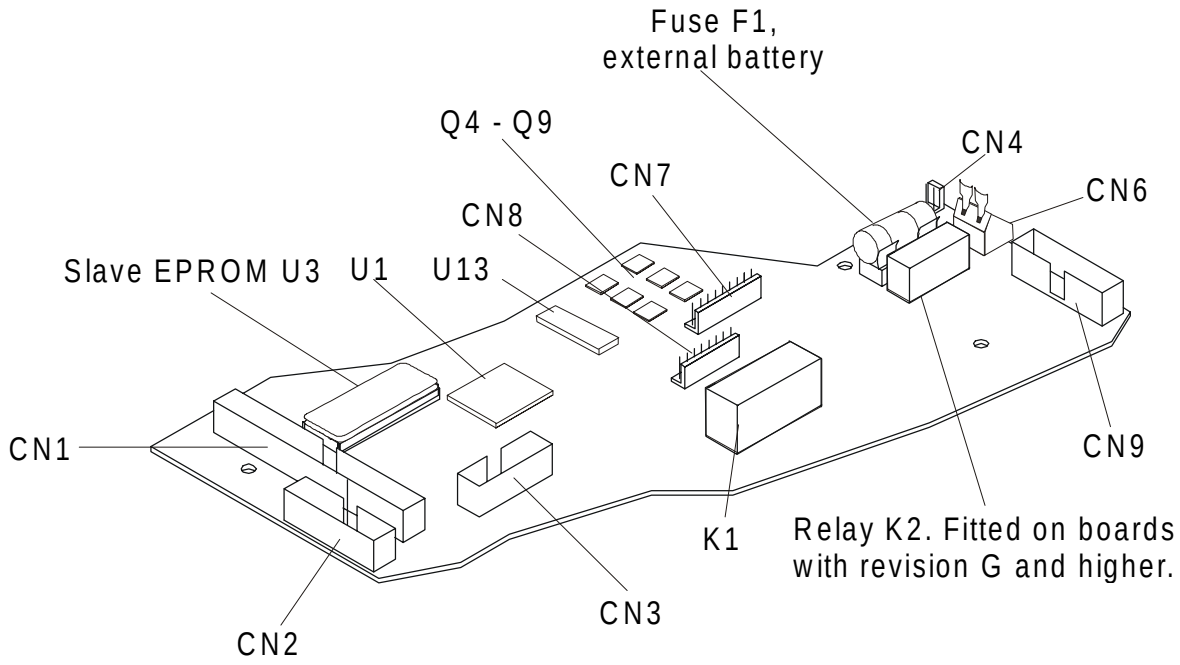

Fig. 6-5 MDA board, Rev. G

6.5 Installation of Internal Battery Kit (accessory)

When an internal battery is installed, the ventilator will automatically switch to the internal backup battery supply if both the mains and the external battery supplies should fail or get disconnected. A short audible alarm is given when switching to the internal battery supply and the green LED indicator in the On/Off switch will start to flash while running from the internal backup battery. An “I” in the Power field of the LCD display also indicates that the ventilator is running from the internal battery supply.

The internal battery pack will run the PV 401-2 for approx. 30 minutes with the Rate and Volume set to the highest possible setting, and in the best case approx. 1 hour with the Pressure set at 20 mbar, Rate at 12 and Insp. time at 1.5 seconds.

The Internal Battery kit contains:

Internal battery pack, complete

1 pce fastening screw

EPROM Version MAX

6.5.1 Installing the EPROM (U4)

- Check the EPROM version currently installed on the CPU board. If it is earlier than MAX it must be replaced with the EPROM version MAX included in the Internal Battery Kit. See “Upgrading the software” on page 8 for information.

6.5.2 Checking for relay K2 on the MDA board

- While the PV 401-2 is open, check if the MDA board has relay K2 installed (see figure 6-5 *MDA board, Rev. G*) as the software must be programmed if the relay is installed or not.

6.5.3 Installing the internal backup battery pack

- Turn the ventilator upside down.
- Remove the small rubber plug to access the terminals for the internal battery wires.
- Connect the red and black wires from the internal battery pack to the two terminals. Make sure that they are connected correctly as shown in the figure.

NOTE. Make sure that no stray wire strand can short-circuit with the circuit board!

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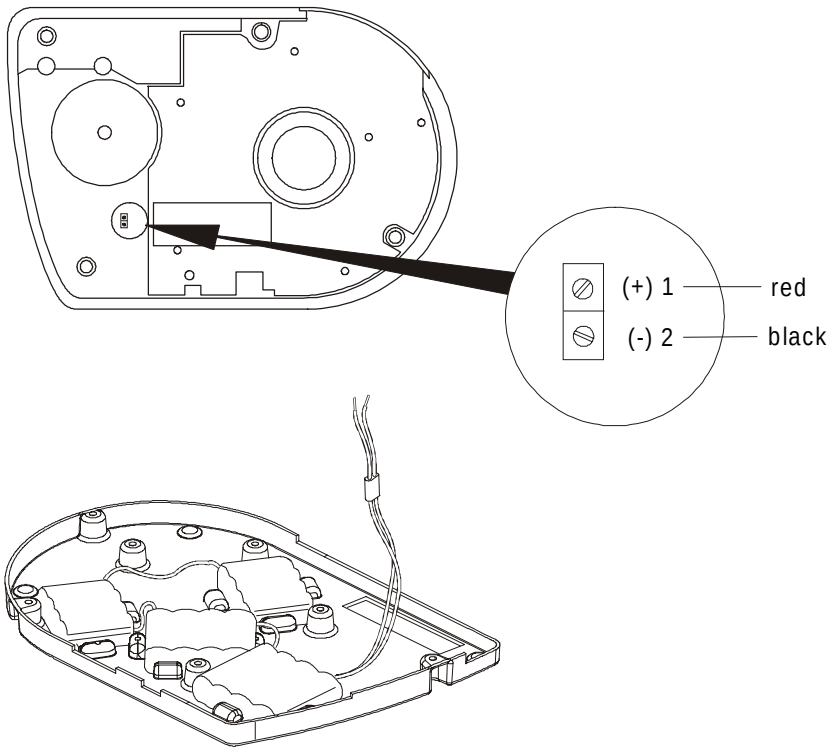


Fig. 6-6 Installing the internal battery pack

- Remove the six screws from the aluminium base plate. Let the base plate remain in place. Fit the internal battery pack making sure that no wire is pinched. Fasten it with the seven screws (the six original screws plus the extra screw from the Internal Battery kit).
- Turn the ventilator over and stand it on its rubber feet.

The internal batteries are charged while the ventilator is connected to the mains supply, even when switched off.

6.5.4 Uninstalling the internal battery pack

- Uninstall the internal battery pack in the reverse order.

Important! The software must be reprogrammed to indicate that there is no internal battery pack installed. See “Programming the software” for more information.

6.6 Upgrading the software

The software is contained in EPROM U4 (Master) mounted on the CPU board and U3 (Slave) mounted on the MDA board.

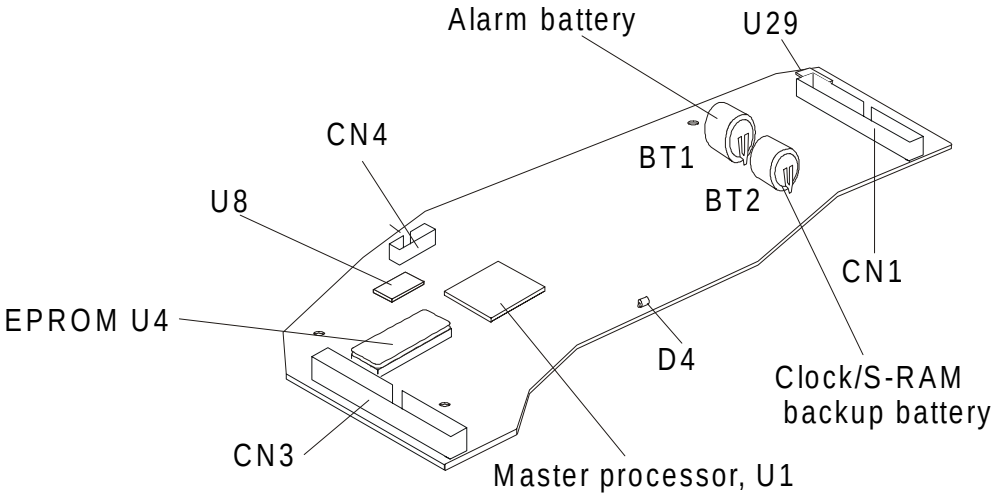


Fig. 6-7 CPU board

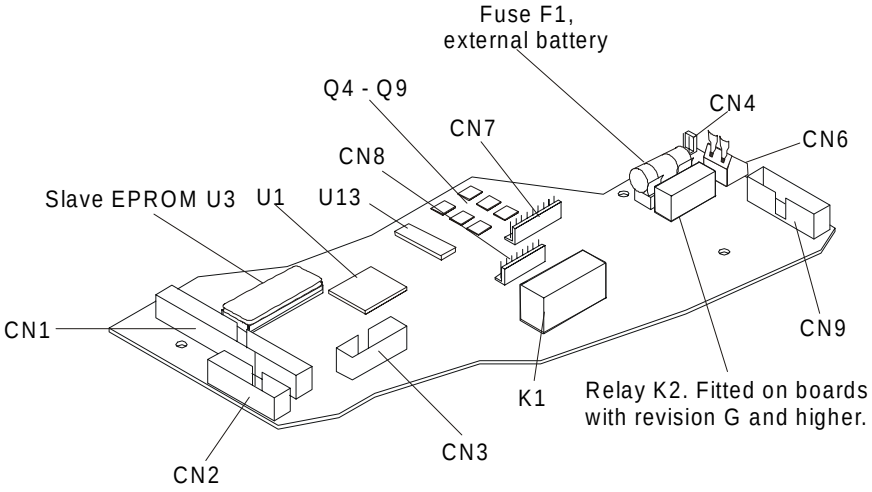


Fig. 6-8 MDA board

Proceed as follows:

- Disconnect the mains supply and (if installed) the external and internal batteries.
- Remove the upper casing (see Section 6.1).
- Using a PLCC capsule puller, pull the EPROM capsule from its socket.

6.7 Programming the software

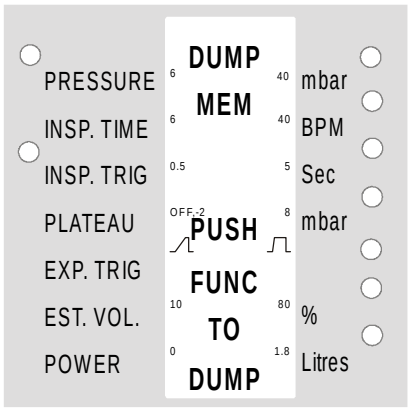
The Master processor (U4) on the CPU board must be programmed for one or more of the following reasons:

1. The MDA board has been replaced with a version with battery relay K2 installed (Rev. G).
2. The CPU has been replace.
3. The Master EPROM (U4) on the CPU board has been replaced with version MAW or later.
4. An internal battery pack has been installed.
5. The internal battery pack has been removed.

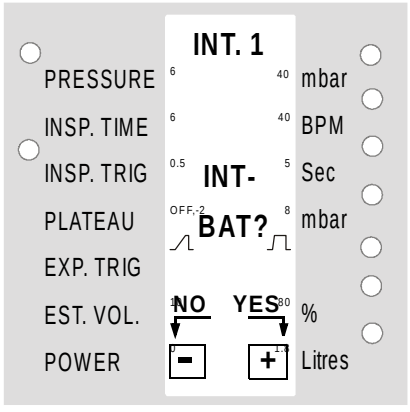
There are two setup menus. The Internal battery setup menu is shown first follow by the setup menu for the battery relay K2 installed on the MDA board. The setup menus can only be accessed in this order i.e. you must run through the Internal battery setup menu before you can access the Battery relay setup menu.

6.7.1 Programming for the Internal Battery pack

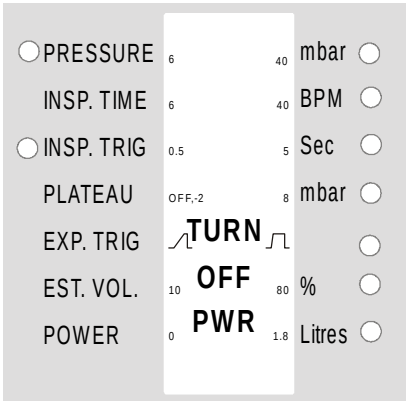
- Press and hold the **+** button.
- Start the ventilator by pressing the ON button.



- Keep the **+** button pressed until the display shows that the ventilator is in the DUMP MODE. Release the **+** button.

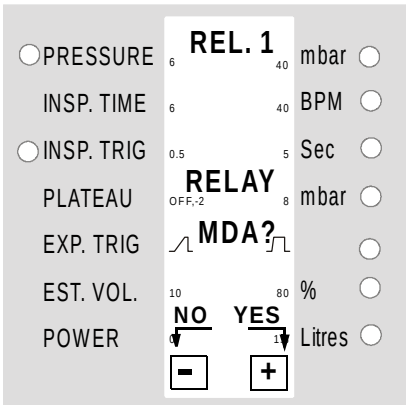


- Press and hold the ALARM SET button for approx. 5 seconds until the prompt, INT. BATT? YES OR NO is shown.The digit in the INT. field shows the current setting, where 0 denotes no internal battery is installed and 1 denotes there is an internal battery installed.
- Press the **+** button (= YES) to indicate that the ventilator has an internal battery pack installed.
- When uninstalling the internal battery pack, answer **−** (= No) here.

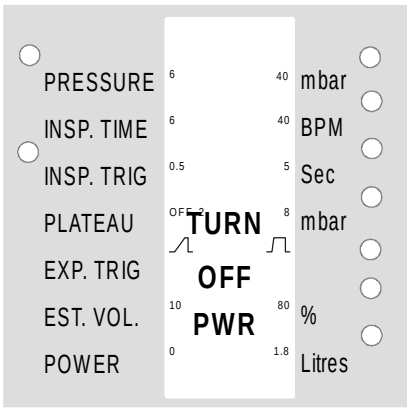


- After a response has been given, the display will change as shown.
- Do NOT switch of the ventilator, but continue to the Battery relay menu by pressing and holding the Alarm Set button for 5 seconds

6.7.2 Programming for the Battery Relay K2



- The Battery relay setup menu is displayed.
- The digit in the REL. field shows the current setting, where 0 denotes that no relay is installed and 1 denotes there is a relay installed.
- Press the **+** button (Yes) if relay K2 is installed or the - button (No)if it is not installed.



- After a response is given the display will change as shown. Switch off the ventilator.
- The software is now updated.

6.8 Removing/Replacing the PGC board

- Remove the upper casing (see Section 6.1).
- Remove the MDA board (see Section 6.4).

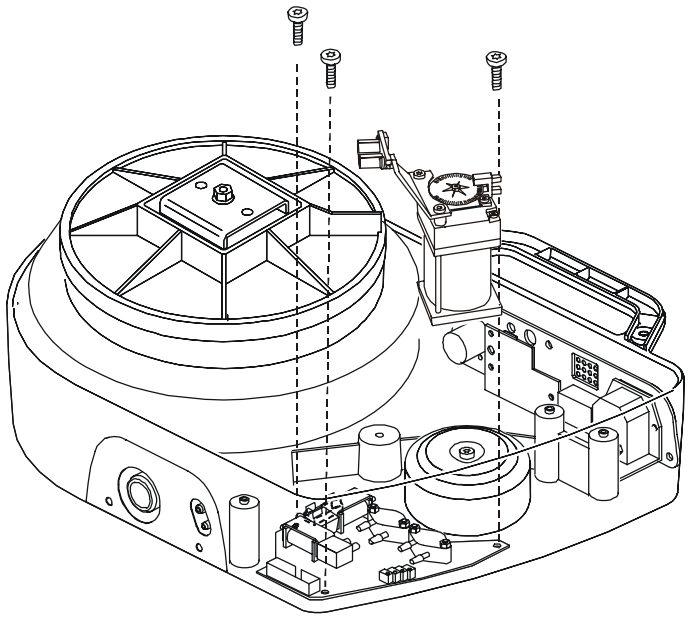
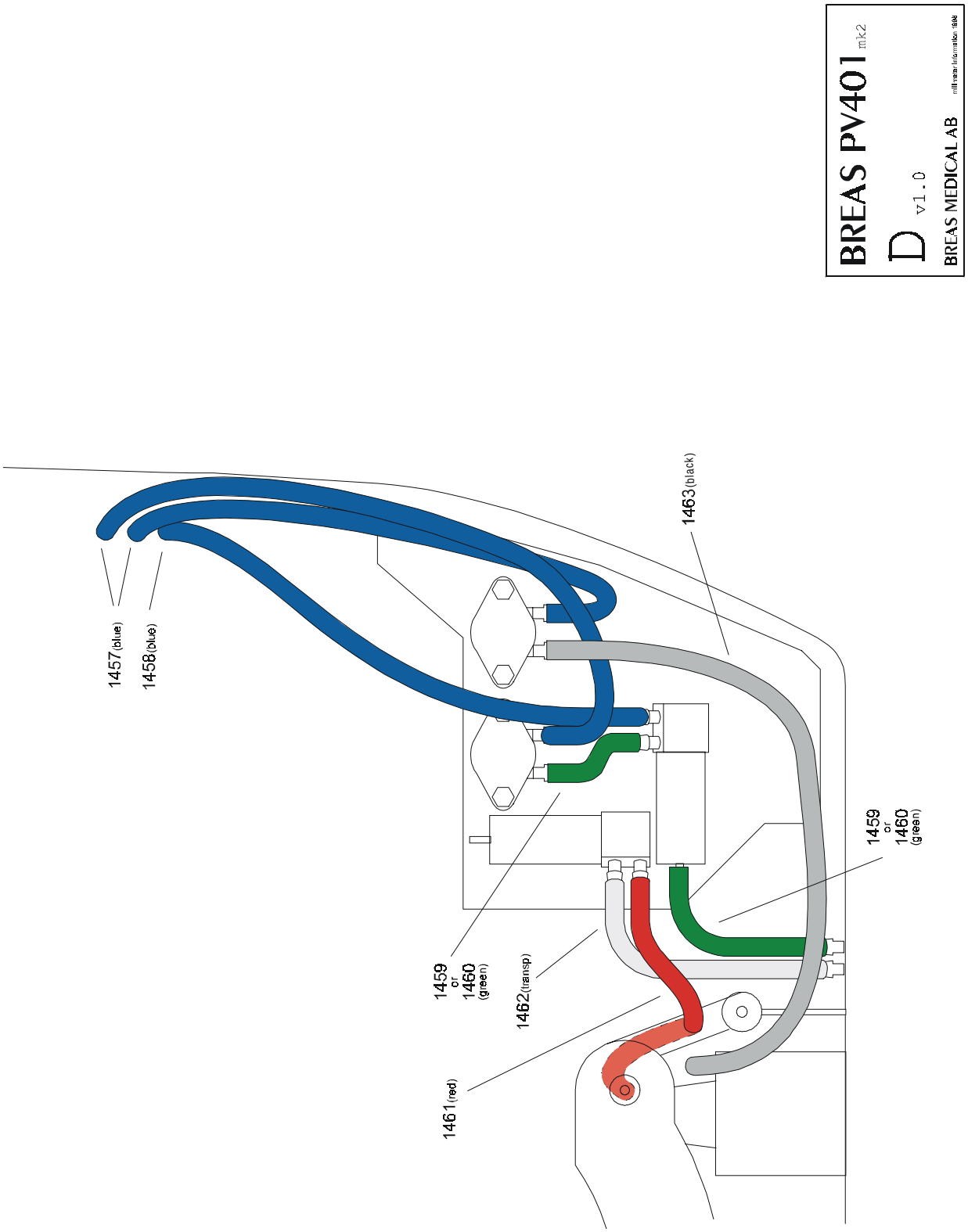


Fig. 6-9 Removing the PGC Board

- Remove the ribbon cable from the MDA board.
- Mark the hoses using a marker pen and pull them from their connectors.
- Remove the three screws that hold the PGC board.
- Reassemble in the reverse order.

6.9 Localisation of air tubes



6.10 Removing/replacing the rear panel complete with transformer

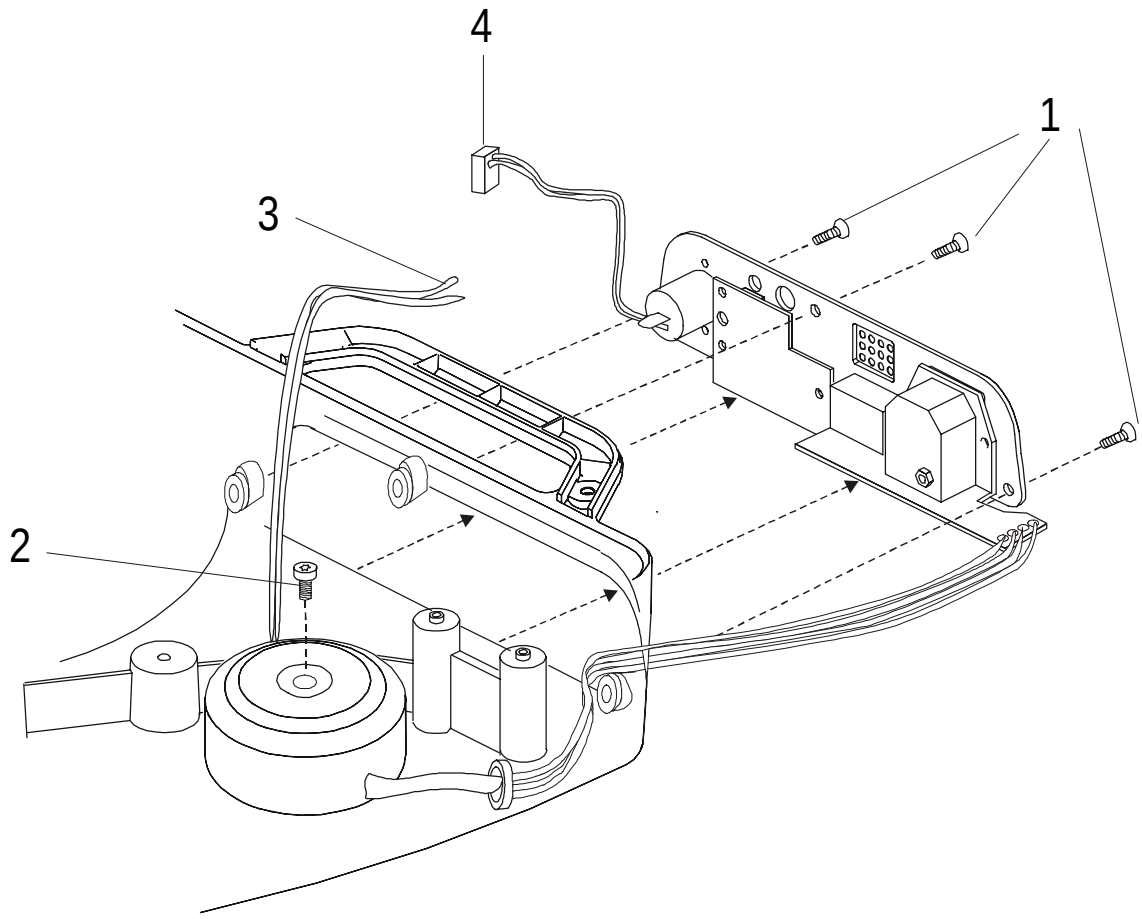


Fig. 6-10 Removing the rear panel with transformer

- Remove the three screws (1) from the rear panel.
- Unscrew the centre bolt (2) that holds the transformer to the lower casing.
- Disconnect the two red wires (3) from CN6 on the MDA board.
- Disconnect the connector for the external battery supply (4) from CN4 on the MDA board.
- From inside the lower casing, push the rear panel and decal outwards. The rear panel can now be passed back through the opening in the lower casing.
- The entire assembly can now be removed.
- Reassemble in the reverse order.

6.11 Removing/replacing the I/O board

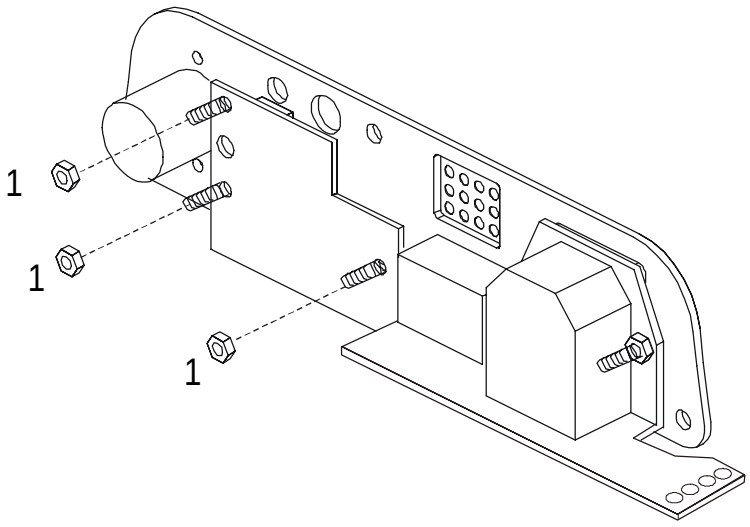


Fig. 6-11 Removing the I/O board

- Disconnect the ribbon cable to the MDA board.
- Remove the three nuts (1) that hold the board and lift it out.
- Reassemble in the reverse order.

6.12 Removing/replacing the MFC board

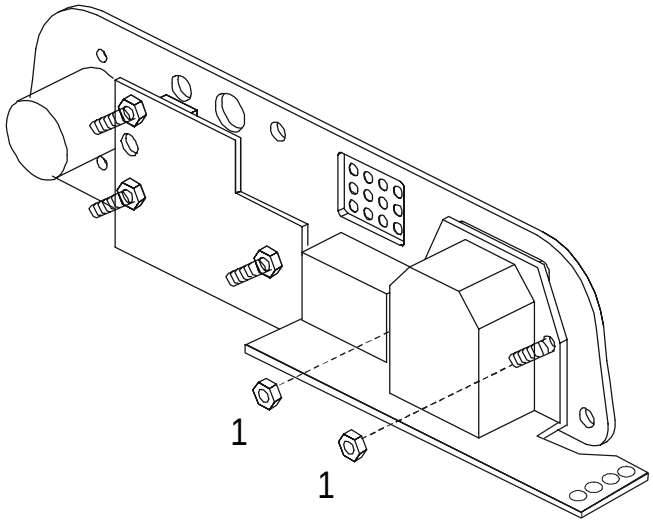


Fig. 6-12 Removing the MFC Board

- Remove the two nuts (1) that hold the power inlet socket to the rear panel.
- Lift away the board.
- Reassemble in the reverse order.

6.13 Removing/replacing the transformer

- Remove the upper casing (see Section 6.1).
- Disconnect the two red wires from CN6 on the MDA board.
- Remove the MDA board (see Section 6.4).
- Unsolder the four wires to the transformer.
  Colours and positions; 1= Yellow, 2 = Blue, 3 = Green and 4 = Black.
- Unscrew the centre bolt that holds the transformer to the lower casing.
- Remove the transformer.
- Reassemble in the reverse order.

6.14 Removing the motor unit from the lower casing

6.14.1 Tools required

Torx key size 20 or Phillips 2 (depending on screw type holding base plate)

7 mm socket with extension.

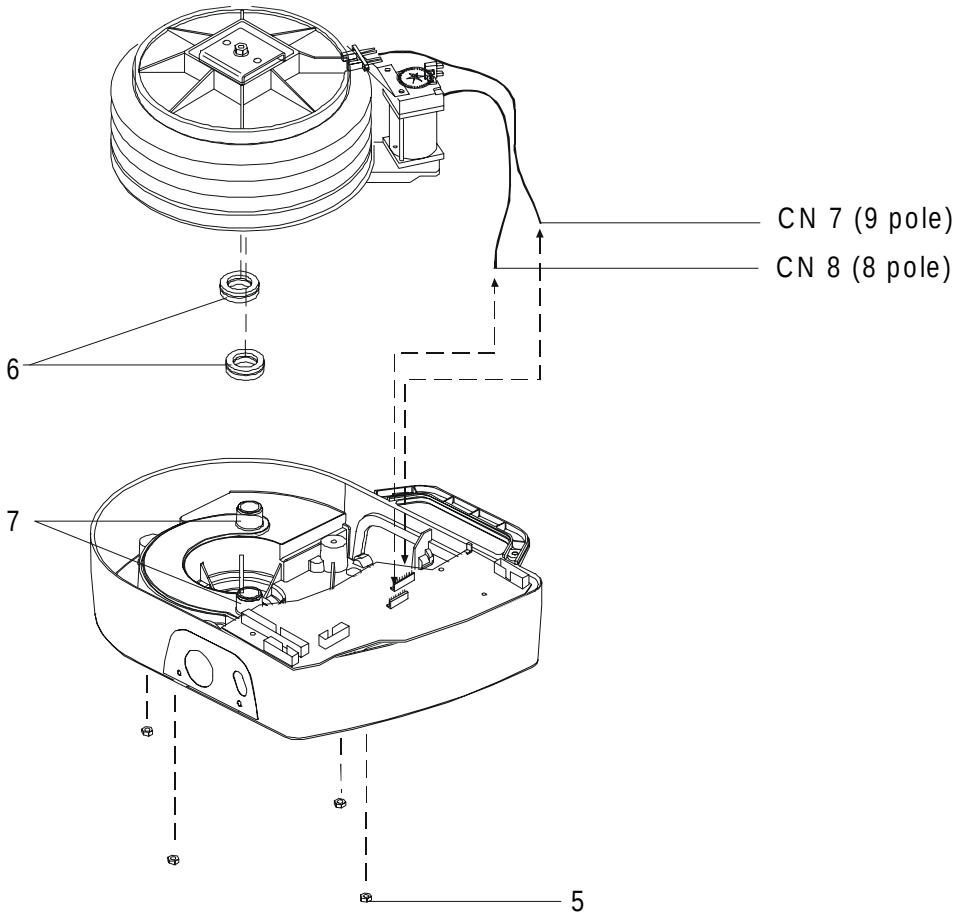


Fig. 6-13 Removing the motor unit

- Remove the internal battery pack (if installed).
- Remove the filter cassette.
- Remove the base plate. Remove the six fastening screws (if no internal battery is installed).
- Remove the upper casing (see Section 6.1).
- Remove the four 7 mm nuts (5) from underneath the PV 401-2 that hold the motor unit (see figure above).
- Disconnect connectors CN 7 and CN 8.
- Grip the motor unit firmly and lift it straight up from the lower casing. If the two silicon seals are loose or remain on the plastic connections, remove them.

6.15 Reassembling/replacing the motor unit

- If necessary, glue the silicon seals into the motor unit to keep the seals in place while mounting. Use a suitable silicon glue, Breas Part No. 1514. Apply a little soapy water to the inside of the two seals and to their corresponding connectors in the lower casing.

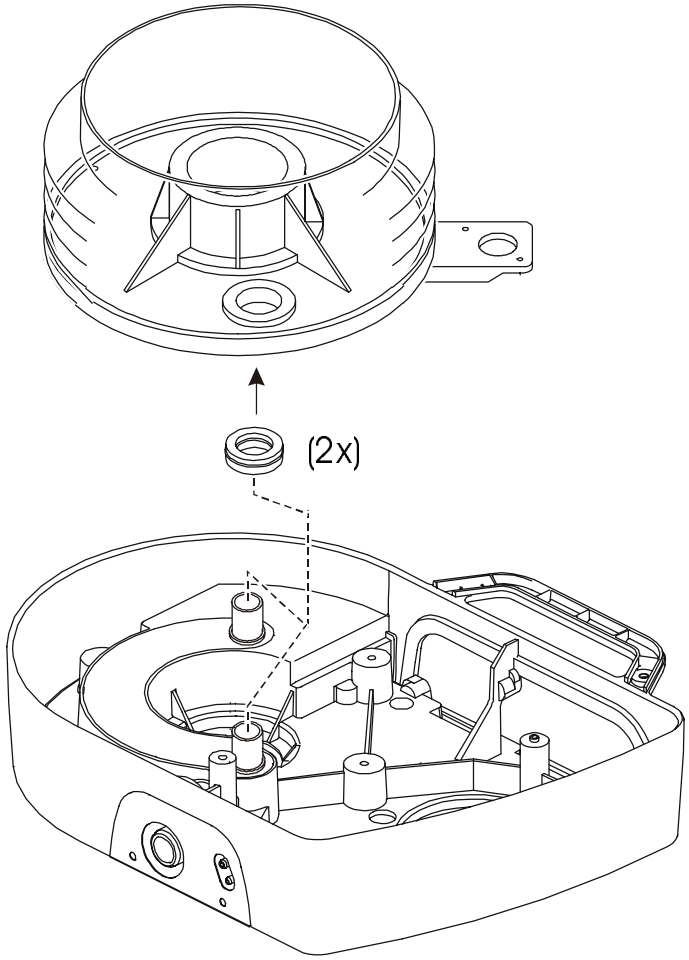


Fig. 6-14 Fitting the silicon rubber seals before assembly

- Carefully push the motor unit into place checking at the same time that the mounting bolts align with their respective holes.
- Fasten the motor unit in place with the four 7 mm nuts. Tighten crosswise using hand pressure.
- Reconnect connectors CN 7 and CN 8. Make sure that all cabling is routed correctly before fitting the upper casing.
- Fit the ribbon cable connector to the MDA board. Fit the upper casing. Fasten with the screw behind the patient air outlet and the two screws for the carrying handle.
- Fit the Torx screws holding the base plate. Fit the filter cassette. If the filter cassette has a tight fit, slacken the screws nearest to the cassette a little so that the cassette can be easily pulled out.
- Start the ventilator and run a function test before putting it back into use.

7 MOTOR UNIT

7.1 Construction

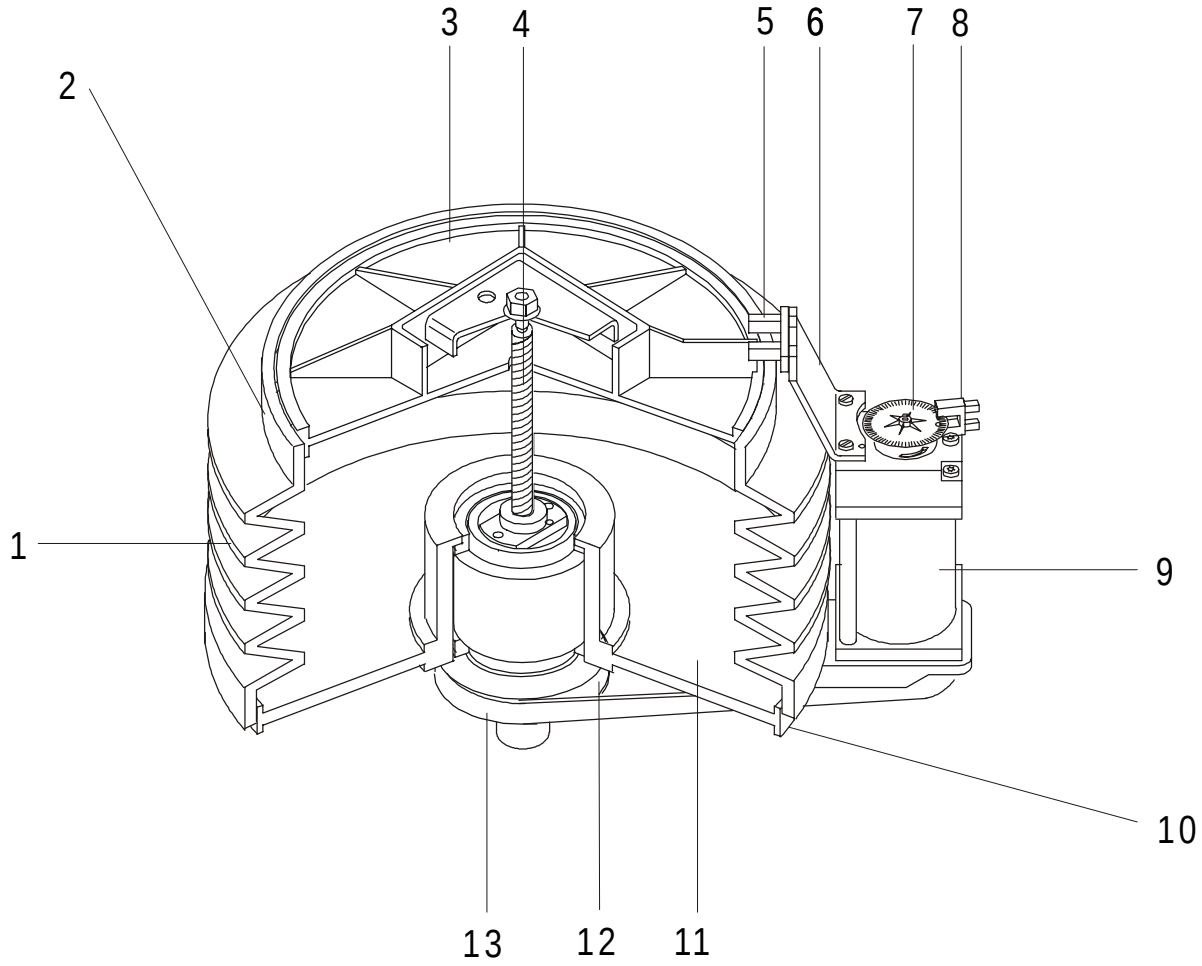


Fig. 7-1 The PV401-2 motor unit

Pos. No.	Description
1	Bellows
2	Bellows clamp, upper, steel
3	Bellows top cover
4	Ballscrew
5	Opto-switch
6	Opto-switch bracket
7	Slotted disc
8	Encoder
9	Motor
10	Bellows clamp, lower, steel
11	Bellows bottom cover
12	Drive belt pulley
13	Drive belt

7.2 Removing the motor unit

Refer to Chapter 6, Section 6.14 for instructions.

7.3 Inspecting/replacing the drive belt

This operation is done with the motor unit removed from the casing. See Chapter 6, Section 6.14 for instructions on removing the motor unit.

- While turning the large pulley, work the drive belt off.
- Check that the drive belt and pulley surfaces are undamaged. Replace the belt at the specified service interval or when necessary.
- Reassemble the motor unit and casing (see Chapter 6, Section 6.15).

7.4 Lubricating the ballscrew

The ballscrew can be lubricated without removing the motor unit.

- Remove the two screws, spacer and nuts that hold the opto-switch bracket to the motor. Move the opto-switch assembly to one side.

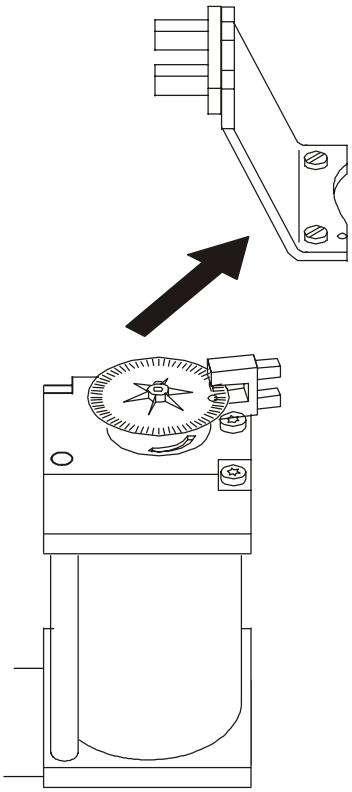


Fig. 7-2 Removing the opto-switch bracket

- Run the bellows up to its top turning point.

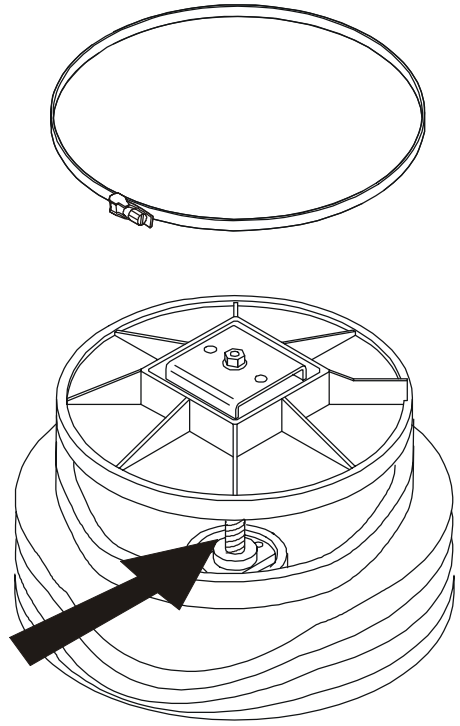


Fig. 7-3 Lubricating the ballscrew

- Remove the upper bellows clamp and pull the bellows from the top end cover.
- Wipe away any old grease and dirt from the ballscrew.
- Apply new grease, type Breas AC.
- Run the ballscrew up and down a couple of times and remove any excess grease.
- Fit the bellows to the end cover and fasten with the bellows clamp.
- Fit the opto-switch assembly to the motor.

7.5 Replacing the membrane in the check valves

This operation is done with the motor unit removed from the casing. See Chapter 6, Section 6.14 for instructions on removing the motor unit.

Before starting work make sure you have at hand a Service kit which contains: 2 pcs membranes, 2 pcs O-ring for the membrane seats, the sealing ring for the patient air outlet and a drive belt.

7.5.1 Replacing the membrane in the check valve under the air channel

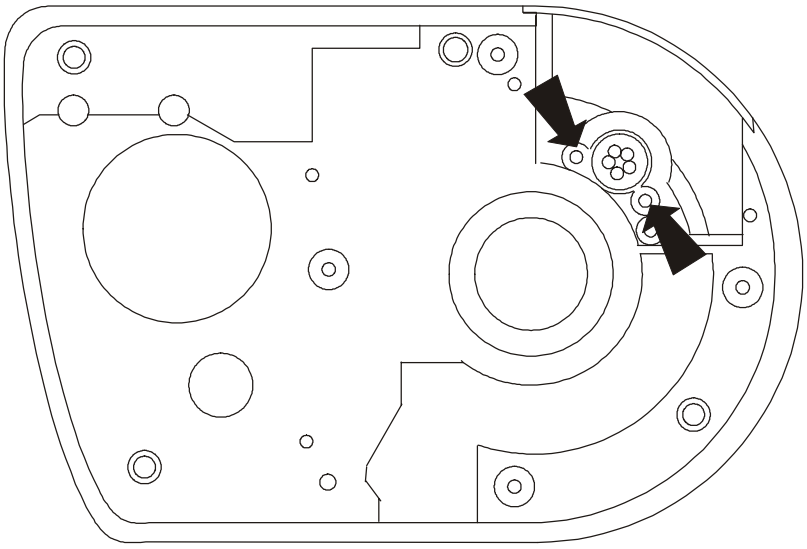


Fig. 7-4 Removing the two screws holding the check valve

- From underneath the ventilator, remove the two screws (indicated by the arrows in figure) that hold the retainers for the check valve.

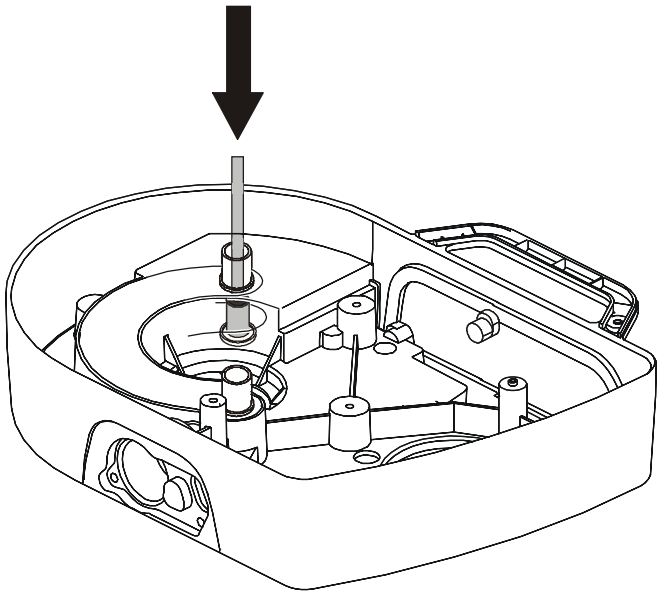


Fig. 7-5 Pressing out the check valve from inside the air channel

- Using a suitable tool, e.g. an 8 mm socket to protect the plastic centre pin of the valve, press out the check valve from above.
- Pull the membrane from the valve seat and remove the O-ring.
- Wipe the membrane seat with a damp cloth.
- Fit the new membrane and O-ring. Make sure it seals properly against its seat.
- Reassemble in the reverse order.

7.5.2 Replacing the membrane in the check valve in patient air outlet

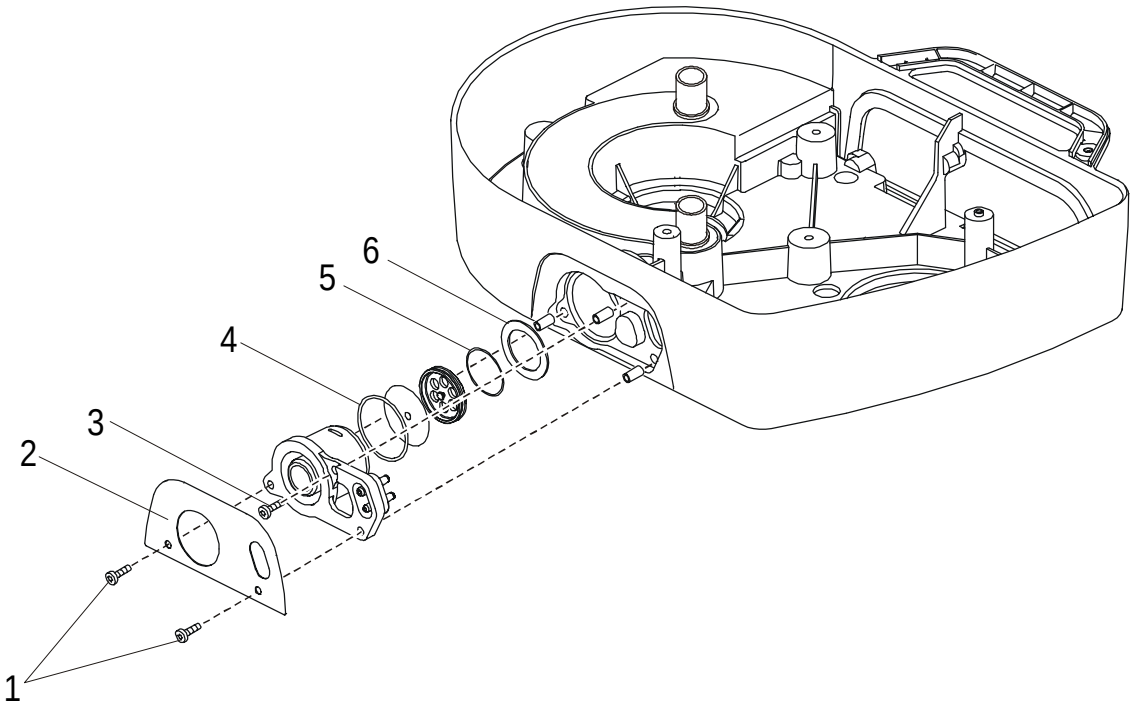


Fig. 7-6 Replacing mambrane in the patient air check valve

- Disconnect the white and green tubes from their connectors behind the patient air outlet moulding.
- Remove the two screws (1) from the front panel. Remove the panel overlay (2).
- Remove the screw (3) holding the patient air outlet.
- Pull out the patient air outlet assembly.
- Using a socket e.g. 8 mm to protect the plastic centre pin, press out the plastic valve seat and membrane.
- Wipe the membrane seat clean using a moist rag.
- Carefully fit the new membrane.
- Make sure that the new membrane lies flat against its seat.
- Fit a new O-ring (4) to the tube connector and screw it back in place.
- Reassemble in the reverse order. Do not forget to fit the new O-ring (5) and rubber seal (6).
- Perform a leakage check to confirm that the check valves are functioning correctly.

7.6 Tubes and bellows, leakage check

- Open the upper casing as shown in the figure below and so that you can access the setting panel. The ribbon cable to the CPU board must remain connected.

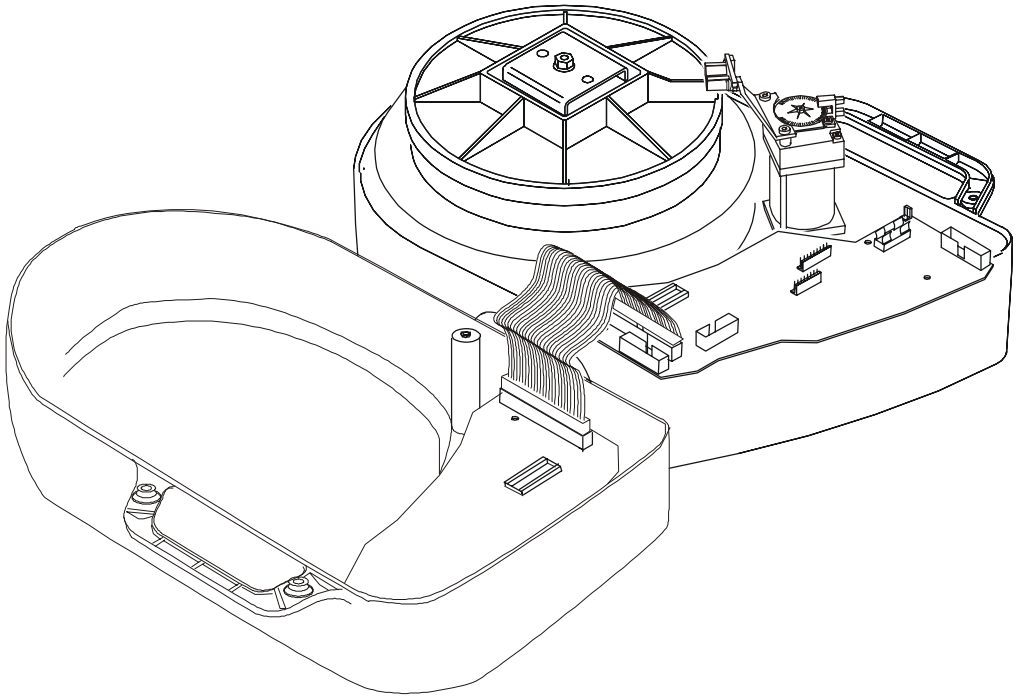


Fig. 7-7 Upper casing opened

- Check that the bellows has not worked loose from its end covers.
- Check that the bellows clamps are properly tightened.
- Connect the mains power supply or an external 24 V battery and switch on.
- Connect the patient circuit to a test lung/reservoir bag.
- Set the following parameters:

Pressure	40 mbar
Rate	6 BPM
Insp.time	5.0 seconds
Mode	PCV

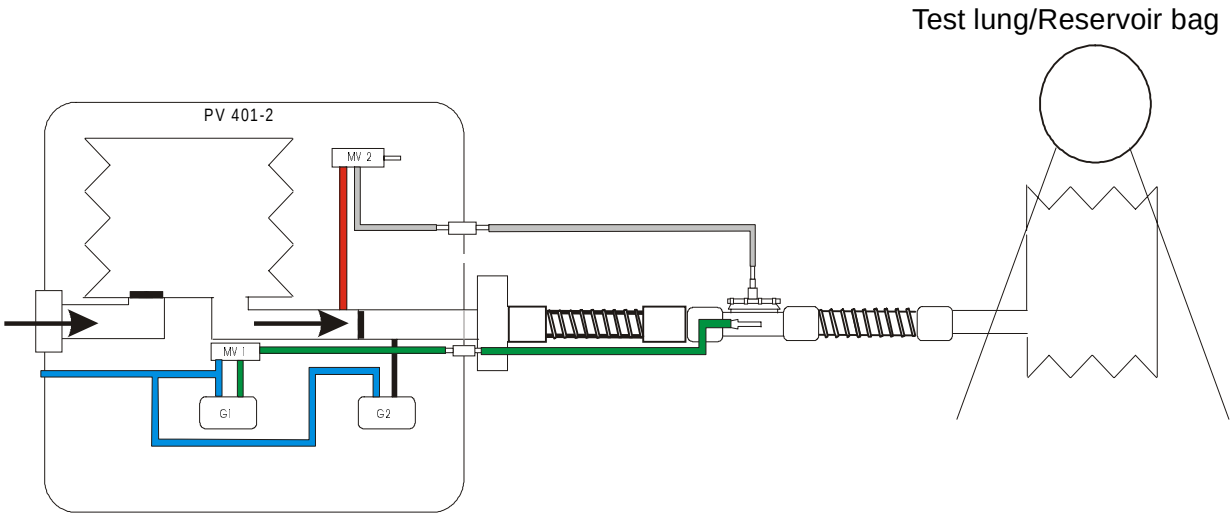


Fig. 7-8 Leakage check of tubes and bellows

- Check that the motor stops when the pressure has reached 40 mbar. If there is any leakage, the motor will continue to work to compensate for the air leakage.

The slotted disc stops rotating when the inspiration phase has reached 40 mbar.

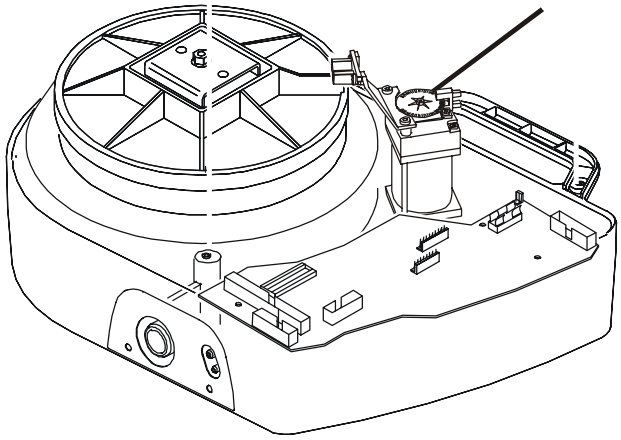


Fig. 7-9 Slotted disc

7.6.1 Leakage check with the ventilator assembled

To perform a leakage check of the tubes and bellows with the ventilator assembled, proceed as follows.

- Adjust the setting as described in Section 7.6.
- Block the patient air outlet and the exhalation air outlet.
- The tidal volume should now indicate 0.05 litre or less. If the tidal volume is higher than 0.05 litre, then there is a leakage.

7.7 Replacing the ballscrew assembly

- Remove the Motor unit (see Chapter 6, Section 6.14).

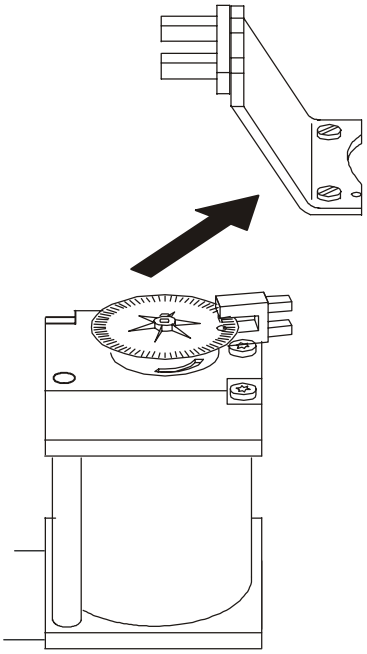


Fig. 7-10 Removing the opto-switch bracket

- Remove the two screws holding the opto-switch bracket to the motor. Move the bracket to one side.
- Remove the upper bellows clamp. Drive the top end cover upwards by turning the belt pulley.
- To avoid damaging the bellows, remove the lower bellows clamp and the bellows.

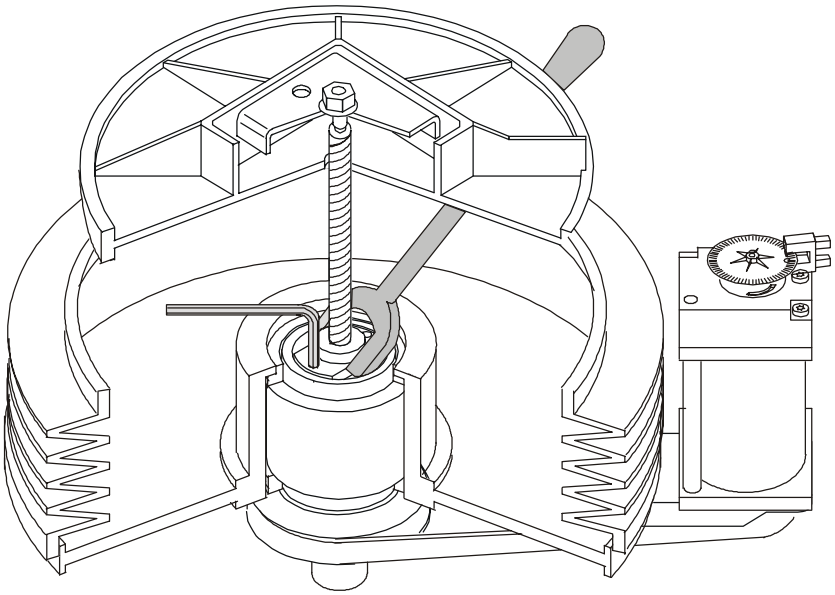


Fig. 7-11 Removing the ballscrew

- Using the special tool as a counterhold for the retainer plate, remove the two Torx screws (1) using an angled 20 mm Torx key.
- The complete ballscrew assembly can now be removed from the bearing housing.
- Fit the ballscrew assembly into the bearing housing.
- Using the special tool as a counterhold for the retainer plate, screw in and tighten the two Torx screws.
- If necessary, grease the ballscrew as described in Section 7.4.
- Fit the bellows and clamps and tighten them.
- Fit the opto-switch bracket.
- The motor unit can now be re-installed.

7.8 Replacing the bearing housing assembly

This operation is carried out with the Motor unit removed from the ventilator.

- Remove the ballscrew assembly as described in Section 7.7.
- Turn the unit upside down.

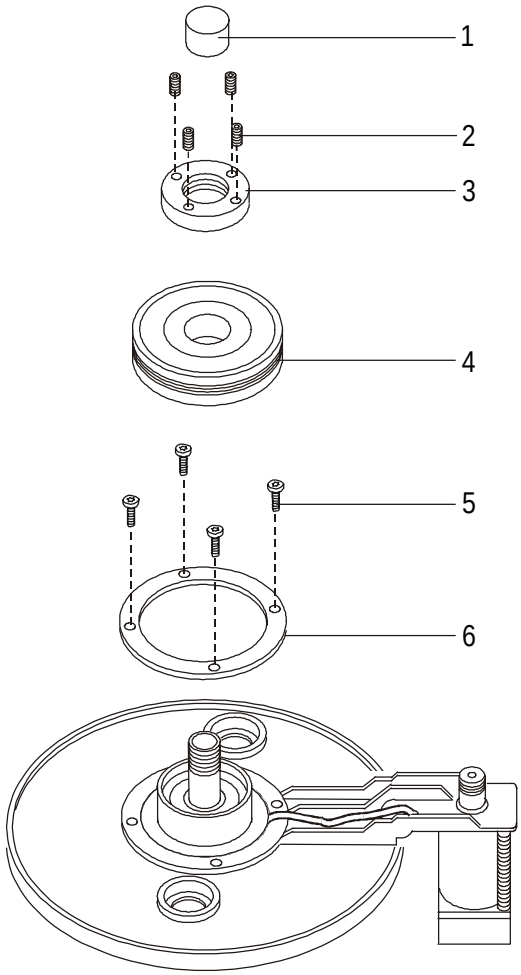


Fig. 7-12 Removing the bearing housing

- Unscrew the red plastic protection cap (1).
- Remove the four Allen screws (2) holding the lock ring (3) and unscrew it from the ballscrew shaft.
- Pull the belt pulley (4) off the shaft.
- Remove the four Torx screws (5) which hold the retainer ring (6). Remove the retainer ring.

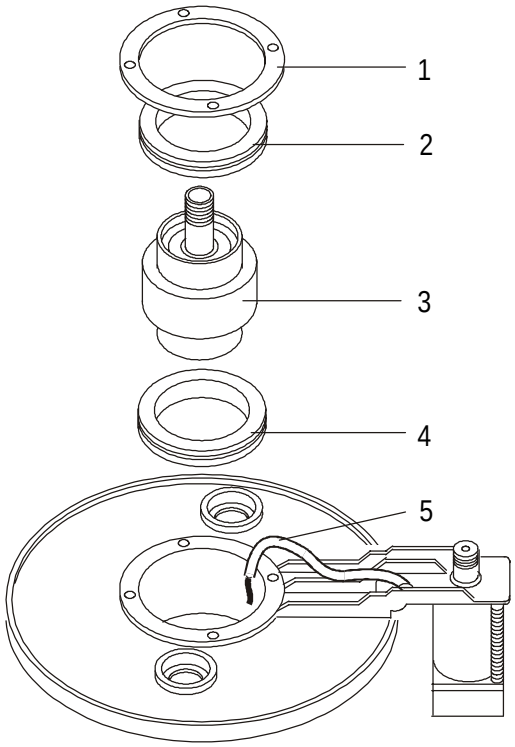


Fig. 7-13 Removing the bearing housing from underneath the lower end cover

- From above, press the bearing housing (3) out of the moulding, taking care not to damage the two silicon-rubber seals (2, 4).
- Fit the upper silicon-rubber seal inside the lower moulding up against the lip.
- Fit the lower silicon seal to the bearing housing assembly.
- Lubricate the seals with a little soapy water to make assembly easier.
- From below, press the bearing assembly into place making sure the black ground wire is fixed between the lower silicon-rubber seal and the bearing housing.
- Fit the retainer ring and fasten in place with the four Torx screws.
- Fit the belt pulley on the shaft.
- Screw on the locking ring and tighten the four Allen screws that hold it place.
- Screw on the red plastic protection cap.
- Install the ballscrew assembly as described in Section 7.7.

8 ELECTRONICS

8.1 Function and construction

The electronics, optics, mechanics and pneumatics in the PV 401-2 are integrated. To understand the electronics used in the Breas PV 401-2 fully, you must know how to use the ventilator, and have studied the air flow diagram and acquainted yourself with the mechanical construction.

The block diagram (PV401T1) below shows how the electronics are arranged and how they are connected to other components.

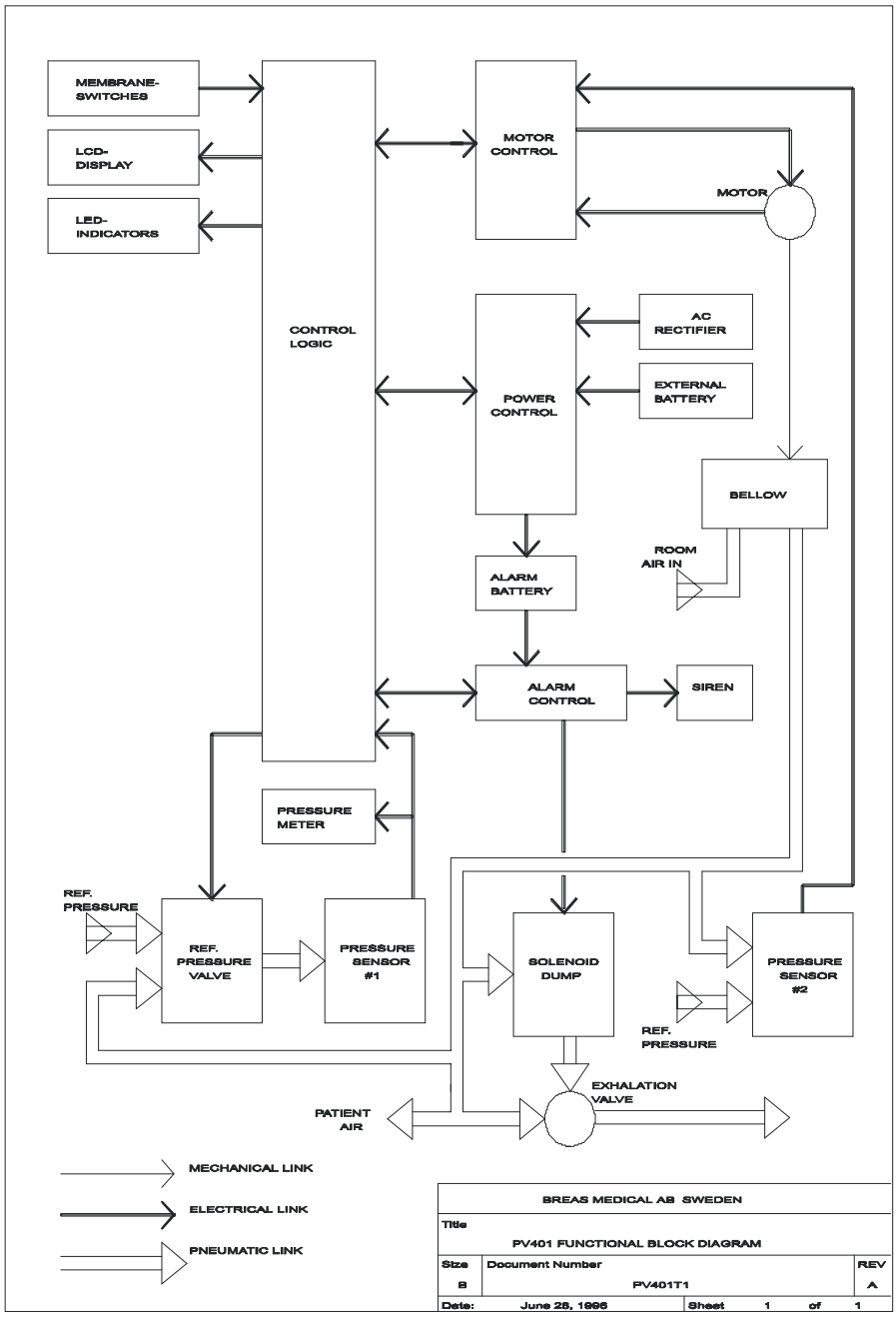


Fig. 8-1 Functional block diagram

The electronics of the PV 401-2 comprises the circuit boards, opto-switches for control of the motor unit, a pushbutton membrane panel and a transformer.

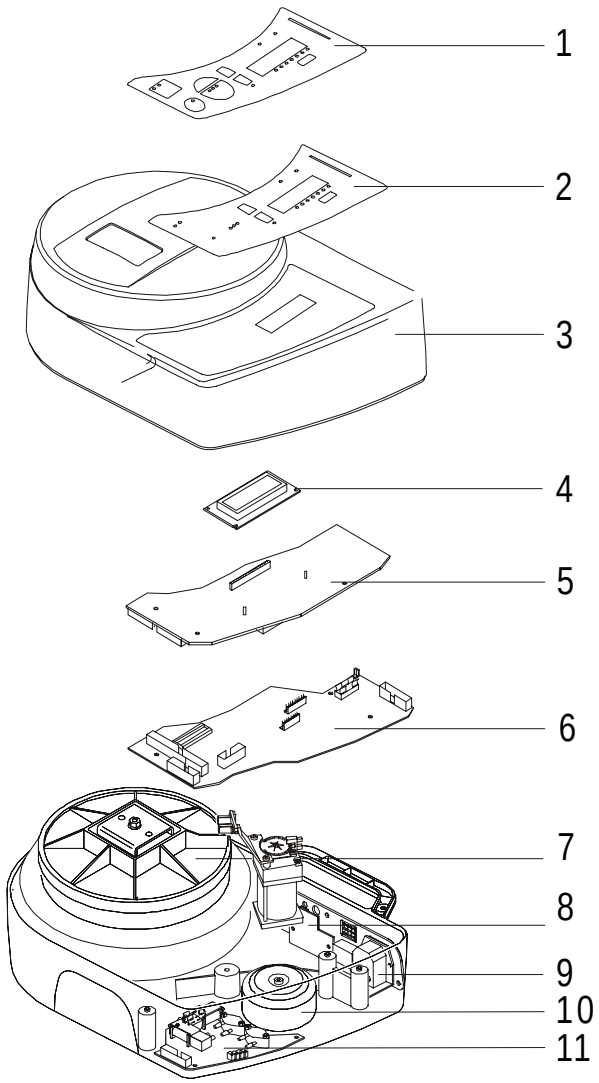


Fig. 8-2 PV 401-2, exploded drawing

Pos.	**Description**
1	Panel decal
2	Membrane pushbutton pad
3	Upper casing
4	LCD display
5	CPU board
6	MDA (Motor Drive Assembly) board
7	Motor unit, complete (also available as exchange unit, part No. 563)
8	IOC (Input/Output Card) board
9	MFC (Mains Filter Card) board
10	Transformer
11	PGC (Pressure Gauge Card) board

8.2 Circuit boards

8.2.1 Pushbutton membrane panel

All pushbuttons, indicator LEDs and the pressure bar indicator are included in this panel.

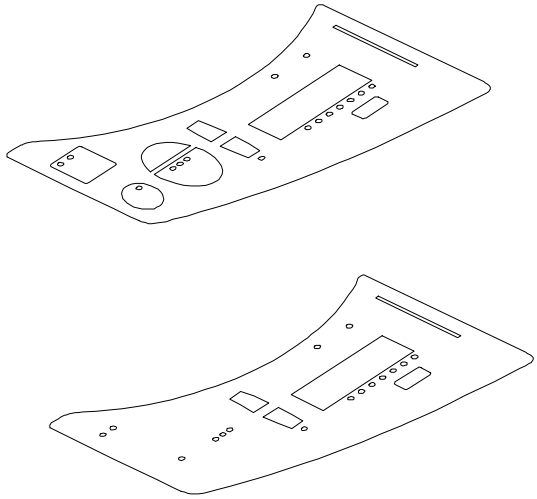


Fig. 8-3 Pushbutton membrane panel and decal

8.2.2 LCD display

The LCD display, is fitted to the CPU board. The contrast of the display can be adjusted by P1 located on the CPU board.

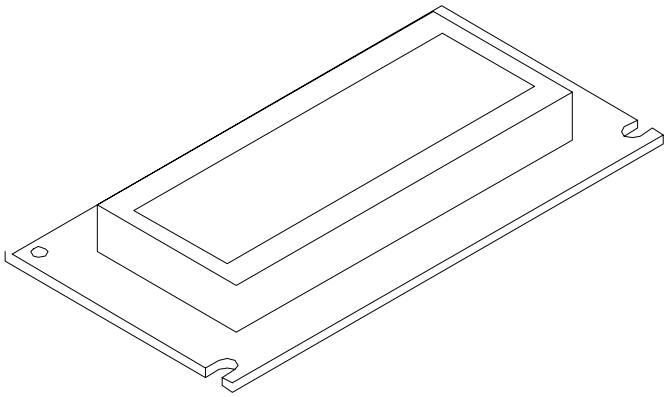


Fig. 8-4 LCD display

8.2.3 CPU board

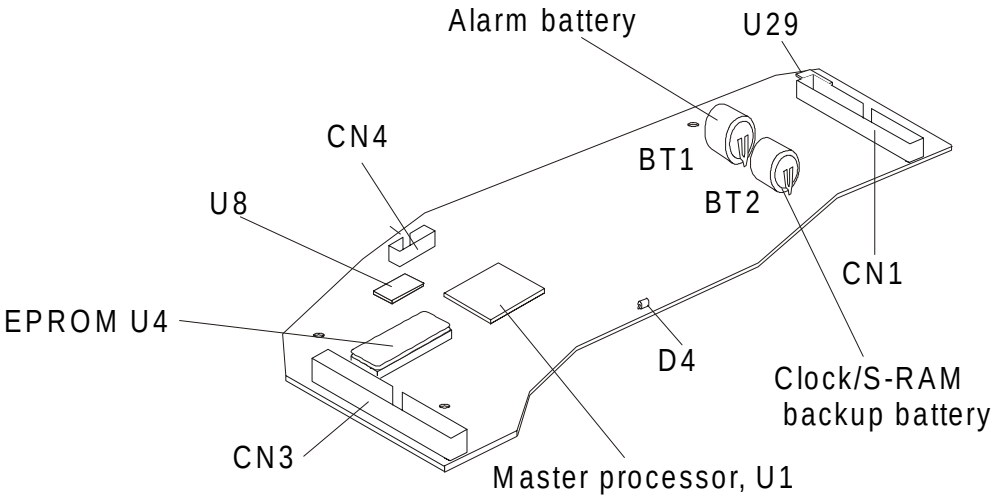


Fig. 8-5 CPU board, seen from underside

The master processor U1 has its program stored in EPROM U4. It reads all button presses and stores the settings in its integrated EEPROM memory. It presents the setting values on the LCD display and controls all the LEDs.

The values are saved just prior to the next breath and the display flashes once. U1 manages all alarm functions, such as low and high pressure, low volume, low power, etc.

The data for each breath is stored in the S-RAM, U8. The breathing data logged comprises, volume, pressure, alarms, etc. This data can be downloaded to a PC and evaluated using the graphical presentations available in the Patient Data Analysis program. This software package, which is also very helpful when fault-tracing, is available from Breas on part number 213990. The bar graph that shows the pressure is run using a multiplexer, therefore there can be a slight flicker. U29 creates the alarm buzzer frequency. The On/Off logic is also located here as well as the constant current diode D4, which charges BT1. Battery BT2 is a lithium battery.

8.2.4 MDA board

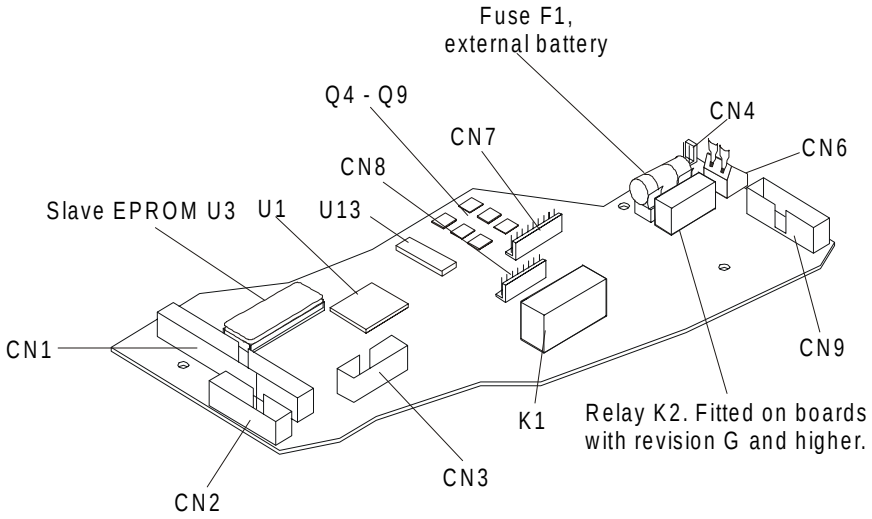


Fig. 8-6 MDA board

The MDA board manages motor control and part of the power supply.

The transformer supplies CN6 with 24 VAC. If an external 24 VDC supply is connected the supply is fed via CN4. The fuse (F1) for the external battery supply is also located on this board. At switch-on, relay K1 supplies the MDA board and other boards with power.

Motor control is managed by the slave processor U1, control circuit U13 and the transistors Q4-Q9.

U1 calculates the momentum of the motor at the beginning of each breath, based on the settings, and regulates towards the set patient pressure with the help of G2.

The opto-switch for the motor registers the home position. The motor speed encoder counts the number of pulses given through the rotating slotted disc on the shaft of the motor to calculate the motor speed and how far the bellows has travelled. The estimated tidal volume, which is shown in the display, is calculated using the number of pulses counted after each breath.

There is a switched 12V regulator which supplies the board with 12VDC. For MDA boards with revision G or later, there is a relay (K2) which switches the DC power between the internal battery (if installed) and the external battery input. The master processor on the CPU board must be programmed whether the MDA board has this battery relay or not. This is done by using the setup menu provided by the master EPROM with version MAW or higher.

8.2.5 PGC (Pressure Gauge Card) board

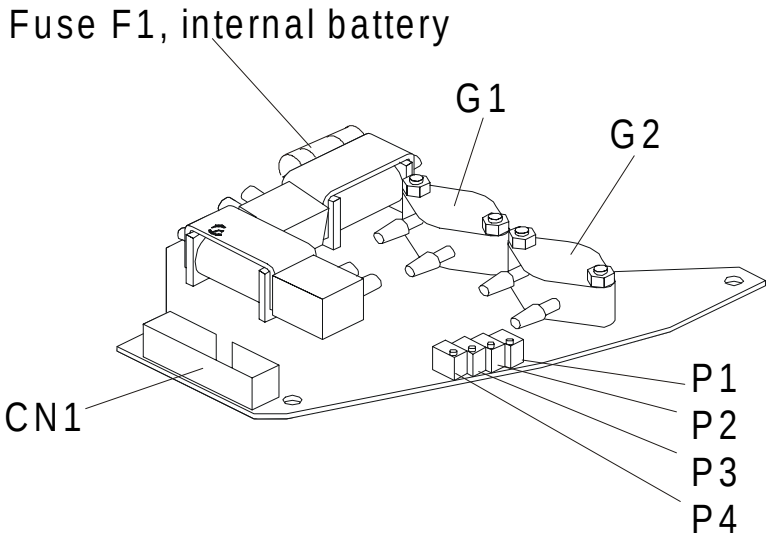


Fig. 8-7 PGC board

The pressure sensors, G1 which monitors and presents the patient air pressure, and G2 which is used for regulating the pressure, are located on this board.

The magnetic valves MV1 and MV2 are located on this board. MV1 is used for calibration of the zero pressure level for the pressure sensor G1. When the trigger function is activated, G1 is automatically calibrated between each breath. MV2 is used as a safety valve at high pressure alarm.

The fuse F1 for the internal battery supply (accessory) is located on this board.

The gain and offset for pressure sensors G1 and G2 can be adjusted by P1 - P4. See “Calibration of pressure sensors” on page 11 for information.

8.2.6 MFC (Mains Filter Card) board

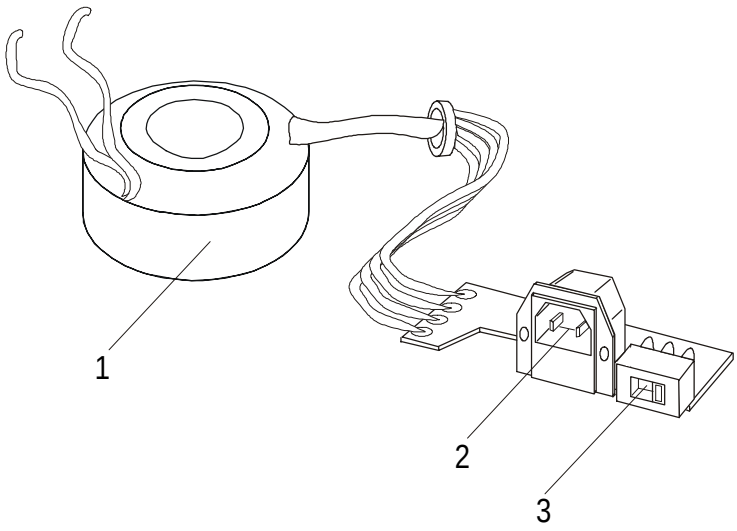


Fig. 8-8 MFC board with transformer

The MFC board provides power to the ventilator via the transformer (1). This board contains the power socket (2), voltage selector (3) and the filter used to prevent electro-magnetic interference both to and from the ventilator.

8.2.7 I/O (Input/Output) board

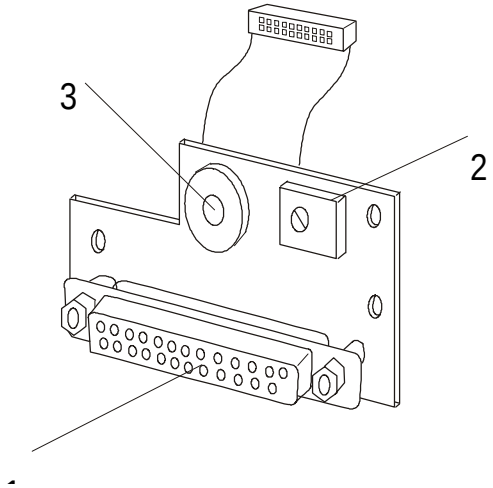


Fig. 8-9 I/O board

This board contains the 25 pin D-sub connector (1) used for digital and analog communication. The trim potentiometer (2) for adjusting the sound level of the alarm buzzer and the alarm buzzer (3) are also located here.

8.3 Main cabling diagram

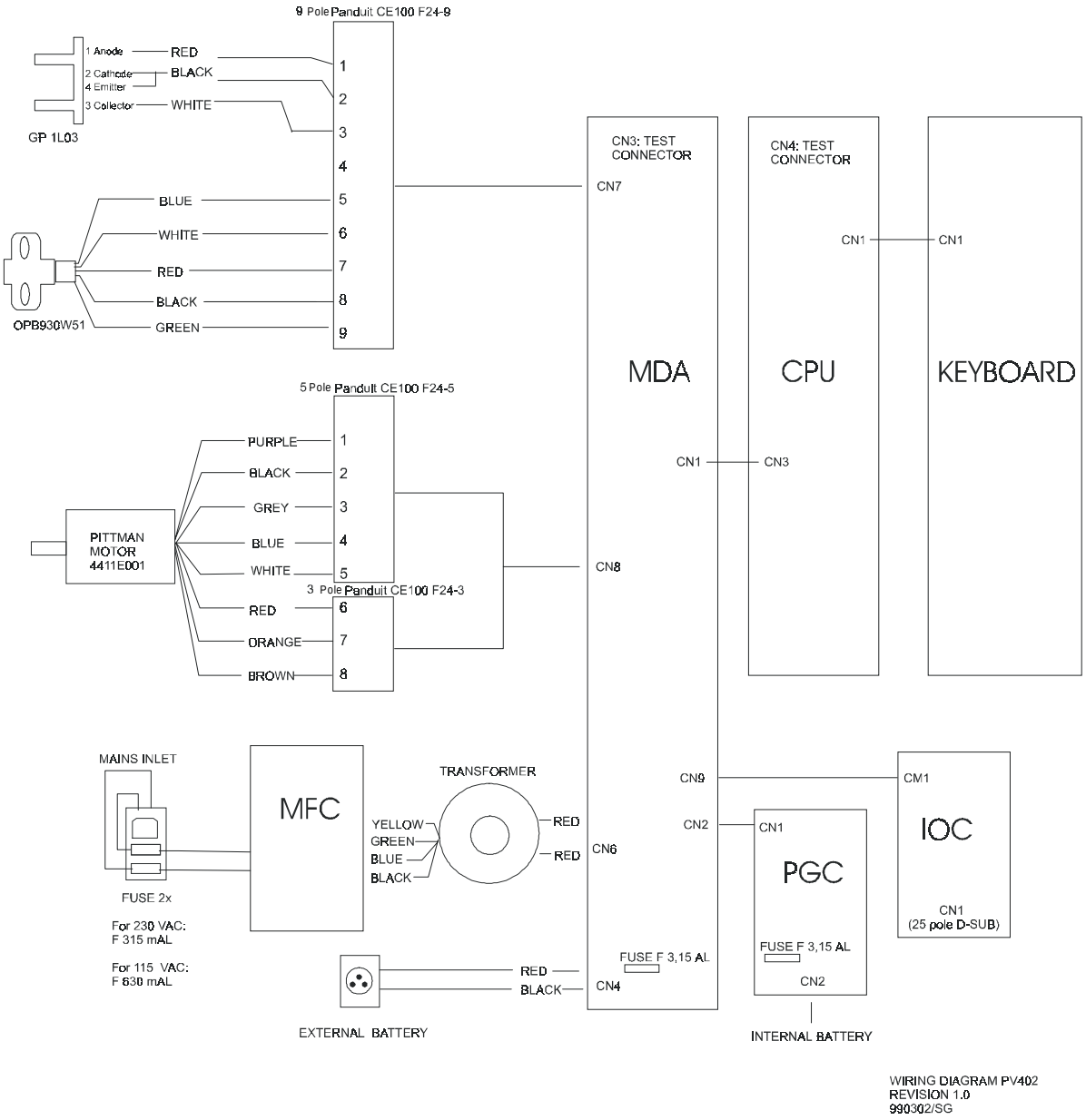


Fig. 8-10 Main cabling diagram

8.4 Test points

8.4.1 MDA board

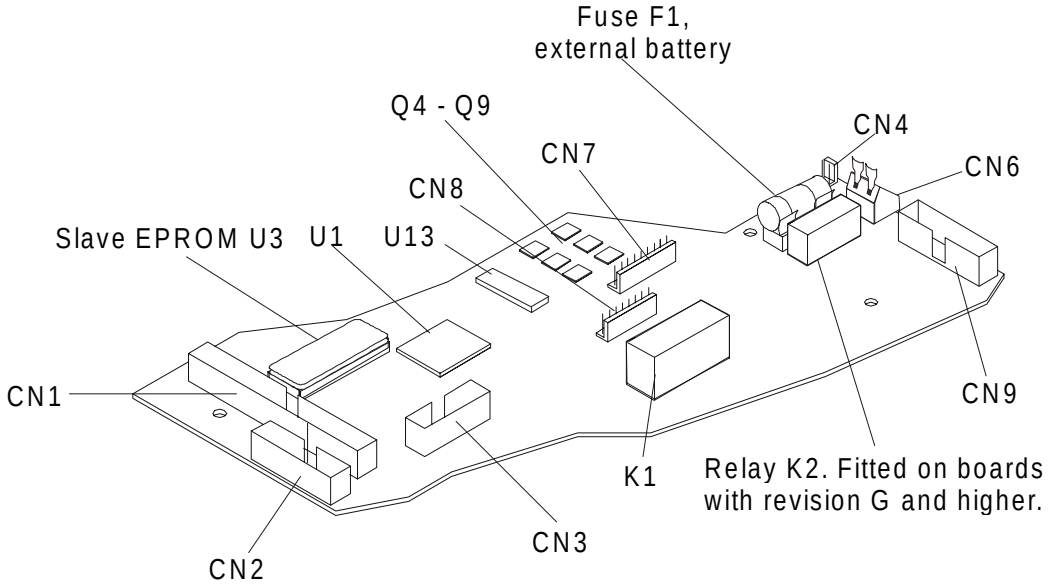


Fig. 8-11 MDA board

Test points	Voltage name	Status	Measured value	Adj. pot.
CN3:1	+ VC	On	30 V DC +/- 5	
CN3:2	+12V	On	12V+/- 0.5	-
CN3:3	Home position opto-sw.	On	Home=5 VDC	-
		Out=0.7 VDC		
CN3:4	Chrg DC 29V	Off,mains connected+29V		R77
		(warning, adjusting R77 too high releases crowbar)		
CN3:5	Pressure amplifier G1	On P=0 mbar1.0 VDC		P1,(P2)
		P=30 mbar 4.0 VDC		
CN3:6	Pressure amplifier G2	On P=10 mbar1.0 VDC		P3,(P4)
		P=30 mbar 3.0 VDC		
CN3:7	Encoder	On	Oscilloscope 0-5VDC	-
CN3:8	+5V	On	5V DC+/- 0.5	-
CN3:9	Not Connected			
CN3:10	Net DC	On Mains	3 V DC	-
CN3:11	Ext DC	On Ext DC	2,2 V DC	-
CN3:12	Int DC	On Int DC	2,2 V DC	-
CN3:13	GND			
CN3:14	GND			

8.4.2 CPU board

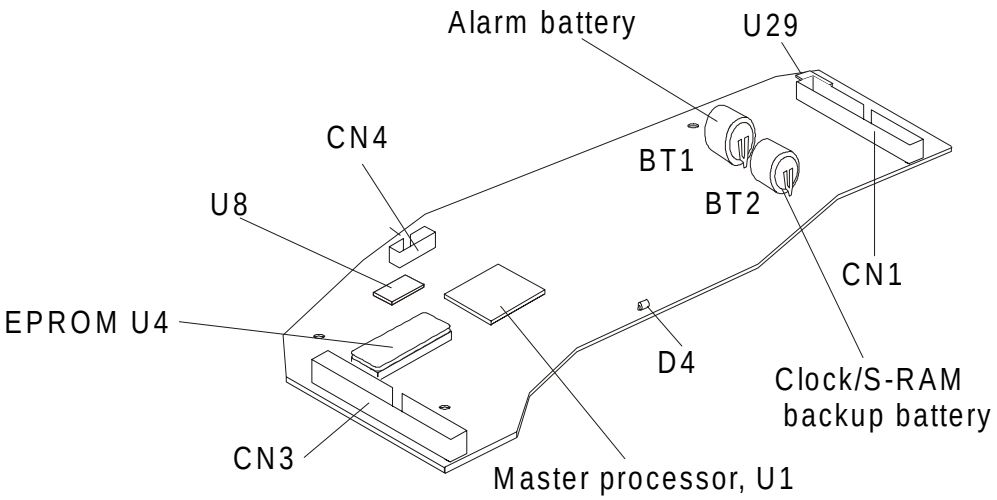


Fig. 8-12 CPU board

Test points	Voltage name	Status	Measured value	Adj. pot.
CN4:1	+5V ref	On	5V DC+/- 0.25	-
CN4:2	+5V	On	5V DC+/- 0.5	-
CN4:3	Spare/Input	-	Do not connect	-
CN4:4	NiMh battery +4.8V	Off	4.8 V DC +/- 0,5	
CN4:5	Lithium Bat. +3 V	Off	3 V DC	
CN4:6	+4	On	4 VDC +/-1	-
CN4:7	Not Connected			
CN4:8	TTL out	-	Do not connect	-
CN4:9	Baud	-	Do not connect	-
CN4:10	Reset CTL	-	Do not connect	-
CN4:11	+12 V DC	On	12 V DC+/- 1	-
CN4:12	-12 V DC	On	-12 V DC+/- 1	-
CN4:13	GND			
CN4:14	GND			

8.5 Calibration of pressure sensors

The PV 401-2 has two pressure sensors, G1 and G2 located on the PGC board.

G1 monitors the pressure at the exhalation valve and presents the value on the pressure gauge. G2 is the pressure regulator sensor.

Let the ventilator run with a test lung connected (with high compliance such that at a pressure of 40 mbar the volume is not larger than 1.2 litre) for 30 minutes so that the ventilator is well warmed-up.

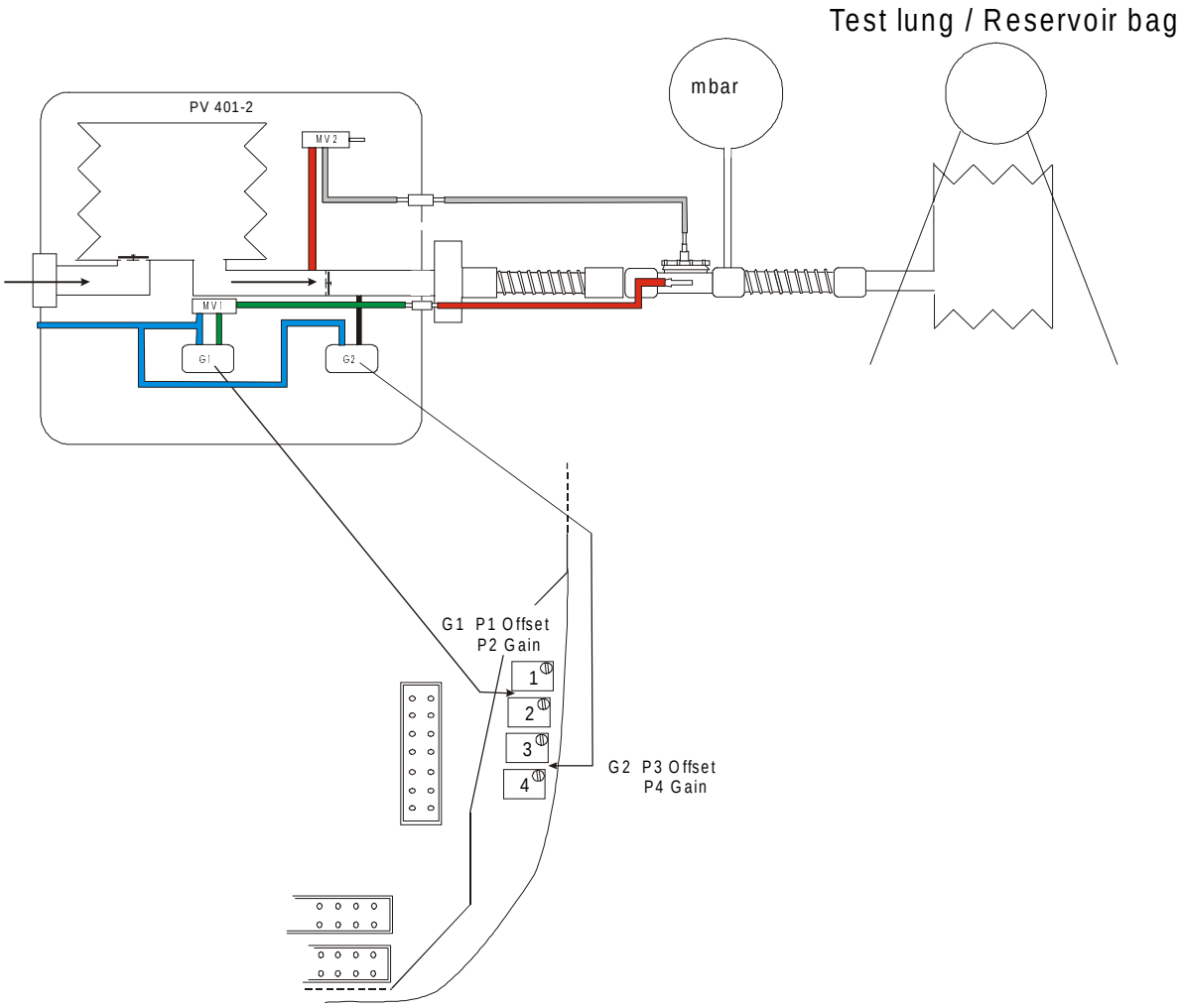


Fig. 8-13 Adjusting the pressure sensors

8.5.1 Adjusting the pressure regulator sensor G2

- Set the parameters as follows:

Pressure	40 mbar
Rate	6 BPM
Insp.time	5.0 seconds
Plateau	max pos. to the right
Mode	PCV

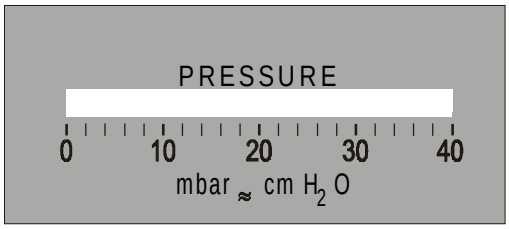
- Make sure that the pressure, at each breath, stabilises at 40 - 41 mbar. If not, adjust P4.
- Set the PV 401-2 pressure to 6 mbar.
- Check that the pressure at each breath stabilises at 6 - 6.5 mbar. If not, adjust P3.
- Repeat steps 1-4 until both pressures are maintained without any adjustment.

8.5.2 Adjusting the pressure measuring sensor G1

- Connect the ventilator as for adjustment of G2
- Set the parameters as follows:

Pressure	30 mbar
Rate	6 BPM
Insp.time	5.0 seconds
Plateau	max position to the right
Mode	PCV

- Make sure that the pressure, at each breath, stabilises at approx. 30 mbar on the pressure gauge. If not, adjust P2.



- Disconnect the patient circuit for the ventilator.
- Check that the voltage at CN 3:9 is 1.00 V (± 0.02 V). If not, adjust P1.
- Repeat steps 1-4 until both pressures are maintained without any adjustment.

8.6 Ventilator switch-over operating voltages

The PV 401-2 will give alarms and switch between the different power sources available according to the conditions described below.

Running from an AC power supply

When running from an AC power supply and the voltage drops as described, the ventilator will react as follows.

If the +VC from the transformer drops below 23.6 V, the PV 401-2 will give a Power Failure alarm or switch over to the external or internal battery if available.

Running from the external battery

- For ventilators with an MDA board WITHOUT relay K2 installed.
  If the voltage drops below 23.6 V, a Power Failure alarm is given or it switches to the internal battery supply, if available.
- For ventilators with an MDA board WITH relay K2 installed.
  If the voltage drops below 22.5 V, a Power Failure alarm is given or it switches to the internal battery supply, if available.

If an internal battery is NOT installed and the external battery voltage drops to 22.7 V, a Low Battery alarm is given and it will continue to run until the voltage drops to 22.0 V. It will then give a Power Failure alarm and switch off.

When the external battery voltage returns to 24 V, the ventilator will switch back to the external battery supply.

Running from the internal battery

With MAX version software installed, if the voltage drops to 23.3V, the ventilator gives a Low Battery alarm and continues to run until the voltage drops to 22.0 V. It will then give a Power Failure alarm and switch off.

If the software installed is earlier than MAX version, the Low Battery alarm level is given at 23,2V

Measuring the voltages

+VC	Measure the voltage at test point CN3:1 on the MDA board.
External battery	Measure the external battery voltage at test point CN:4 on the MDA board.
Internal battery	Measure the internal battery voltage at test point CN:2 on the PGC board.

8.7 Checking the internal battery

- Make sure that the battery is fully charged.
- Set the parameters as follows:

Pressure	40 mbar
Rate	20 BPM
Insp.time	3.0 seconds
Mode	PCV

- Connect a test lung and start the ventilator. Measure the time it takes before the ventilator starts to alarm for Low Battery level (approx. 25 minutes).
- Then measure the time the ventilator runs after the Low Battery alarm was given (approx. 5 minutes).

8.8 Checking external battery operation

This check can only be performed without the internal battery installed. If there is an internal battery installed, the ventilator will automatically switch to the internal battery supply when the external battery voltage drops too low. In this case, just check that the ventilator switches to the internal battery supply.

To check the operation and the low voltage alarm of the external battery (without an internal battery installed), proceed as follows:

- Set the following parameters:

Pressure:	6 mbar
Rate:	8
Insp.time:	3 seconds
MODE	PCV

- Connect a 1 litre test bladder with an exhalation valve.
- Connect an adjustable DC power supply unit to the external 24V socket of the ventilator.
- Set the voltage to 24V.
- Switch on the ventilator, and make sure the LED in the ON/OFF button flashes.
- When the external battery voltage drops to 22.5V(± 0.2V) the low battery voltage alarm will start.
- Run the ventilator and slowly reduce the voltage to 22.5V.
- Check that a “power alarm” is given as a sound blast every five seconds at 22.5 V (± 0.2 V).
- Again, slowly reduce the voltage down to 22.0 V. Check that the ventilator switches off at 22.0 V(± 0.2 V) and that the red LED for “POWER” is lit.

8.9 Replacing the alarm battery BT1 and memory battery BT2

The alarm battery BT1 and the memory battery BT2 are located on the CPU board.

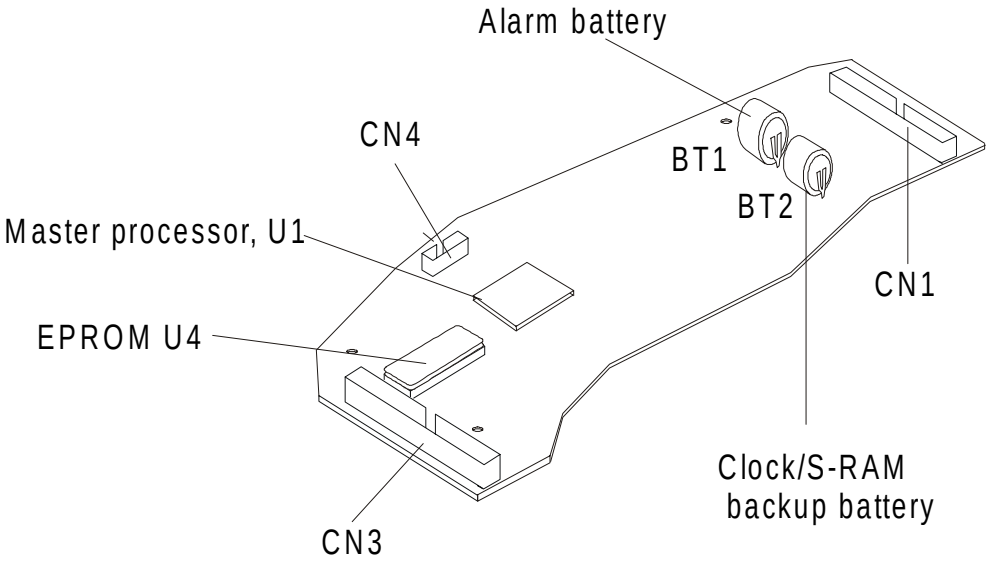


Fig. 8-14 CPU board

The batteries must be replaced after 5 years from the delivery date, or from the date they were last replaced.

To replace the batteries:

- Disconnect the mains power supply and any external battery.
- Remove the CPU board.
- Remove the LCD Display board.
- Unsolder the two pins for each battery and remove them.
- Remove any remaining solder from the holes.
- Fit the new batteries, checking the polarity, and solder them in place.
- Fit the LCD Display board to the CPU Board.
- Fit the CPU Board.
- Make a test start.
- The PV 401-2 checks, at each start-up cycle, the condition of the alarm battery.
- If a fault occurs with the alarm battery, the ventilator will not start and the LED for “POWER” will light and the error message FAIL 08 is displayed. If this should happen after replacing the battery, let the ventilator remain switched off for a few hours but still connected to mains supply, so that the battery is charged.
- Restart the ventilator.
- With the ventilator running from the mains supply, pull out the power cord. The red LED “POWER” should light and an audible alarm given. When the power supply is reconnected, the ventilator should re-start normally.

8.10 Setting the Date and Time

Refer to the Setting the Date and Time section in the Operating Manual.

8.11 Erasing the Calendar memory

Before the contents of the Calendar memory can be erased, the patient data must first be downloaded. After the download is completed, press and hold the Mode button for 5 seconds. The memory will be erased and the display will show the MEMory CLeaR ReaDY message.

The Calendar memory can also be erased from the Patient Calendar Data Analysis program

Switch off the ventilator.

8.12 Electrical safety precautions

Electrical safety measurements must be taken according to IEC 601. However, the insulation resistance can be measured instead of the voltage test specified by the standard.

The measurements can be taken using an automatic electrical safety tester. All tests must be done according to class II type BF.

Supply voltage

Note the power voltage reading. As the currents measured are directly in relation to the supply voltage, the voltage must be noted for each service check. This allows all measurements made on the same ventilator to be compared with measurements made on different occasions.

Insulation

The insulation resistance is measured using a 500 VDC power supply. The most suitable method is to connect the plus lead to both the ventilator power socket pins and minus to the casing or patient air connector. The measurements taken during the delivery inspection provide the reference values with which measurements taken during later services are compared to. If no reference values are available, the value for the insulation resistance should be > 20MΩ.

Leakage currents

Leakage currents are measured at different parts of the ventilator using an RC circuit to ground.

The measurements are taken partly at normal case (NC) and at the single fault condition (SFC). Reverse the polarity of the power supply and note the lowest value.

Leakage currents to ground must not exceed the stated limit values.

Leakage currents from the casings

The leakage current of the casing.

Measured at an unpainted point, e.g. the head of a screw.

Limit values:	NC	< 0,1mA
	SFC	< 0,5mA

Break neutral for SFC.

Patient leakage currents

Measured between the patient connector and ground.

Limit: values	NC	< 0,1mA
	SFC	< 0,5mA

Break neutral for SFC.

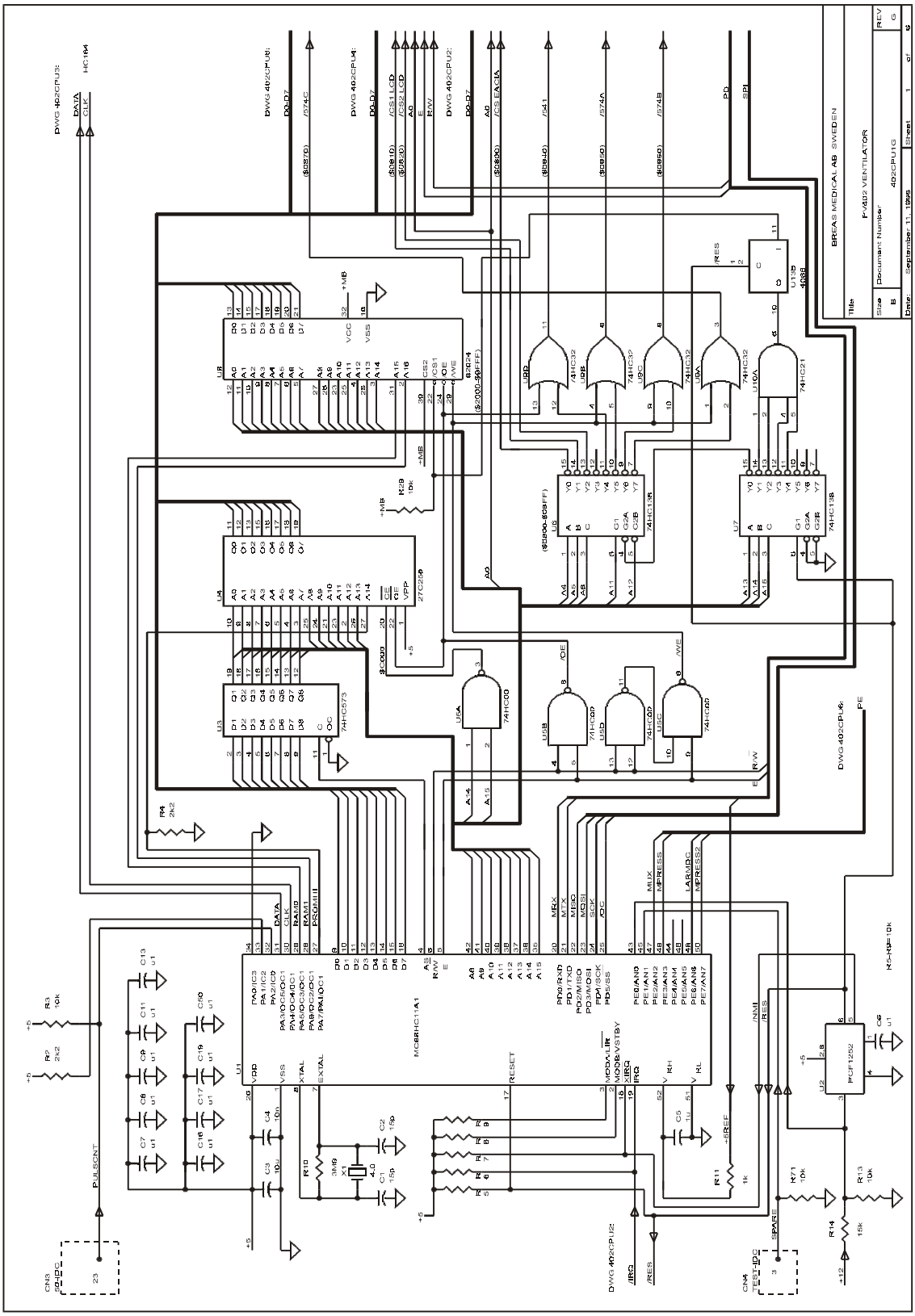
Leakage currents with mains power supply at the patient connected part

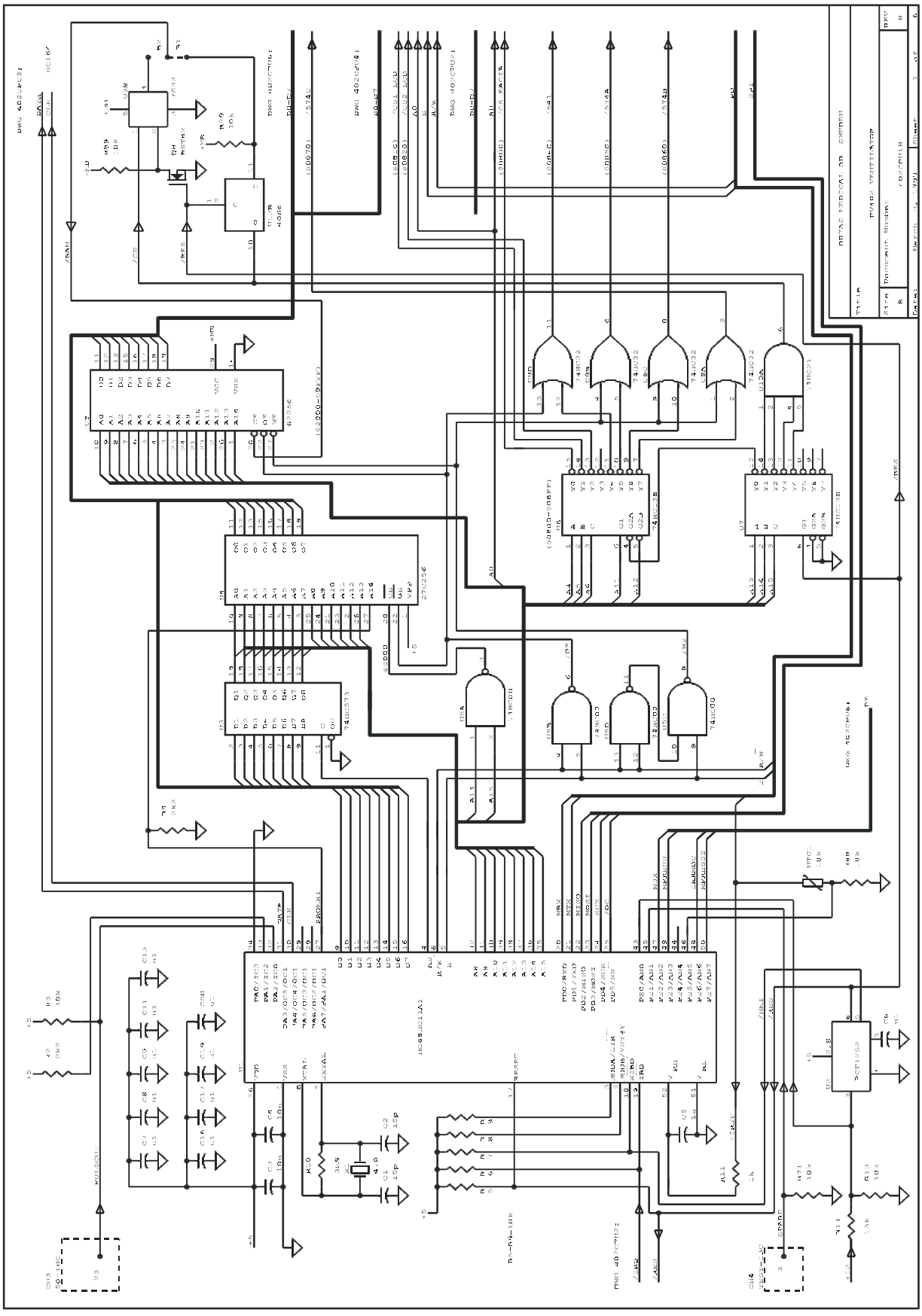
This test must be done using an automatic electrical safety tester which has this function. See the safety instructions for the tester.

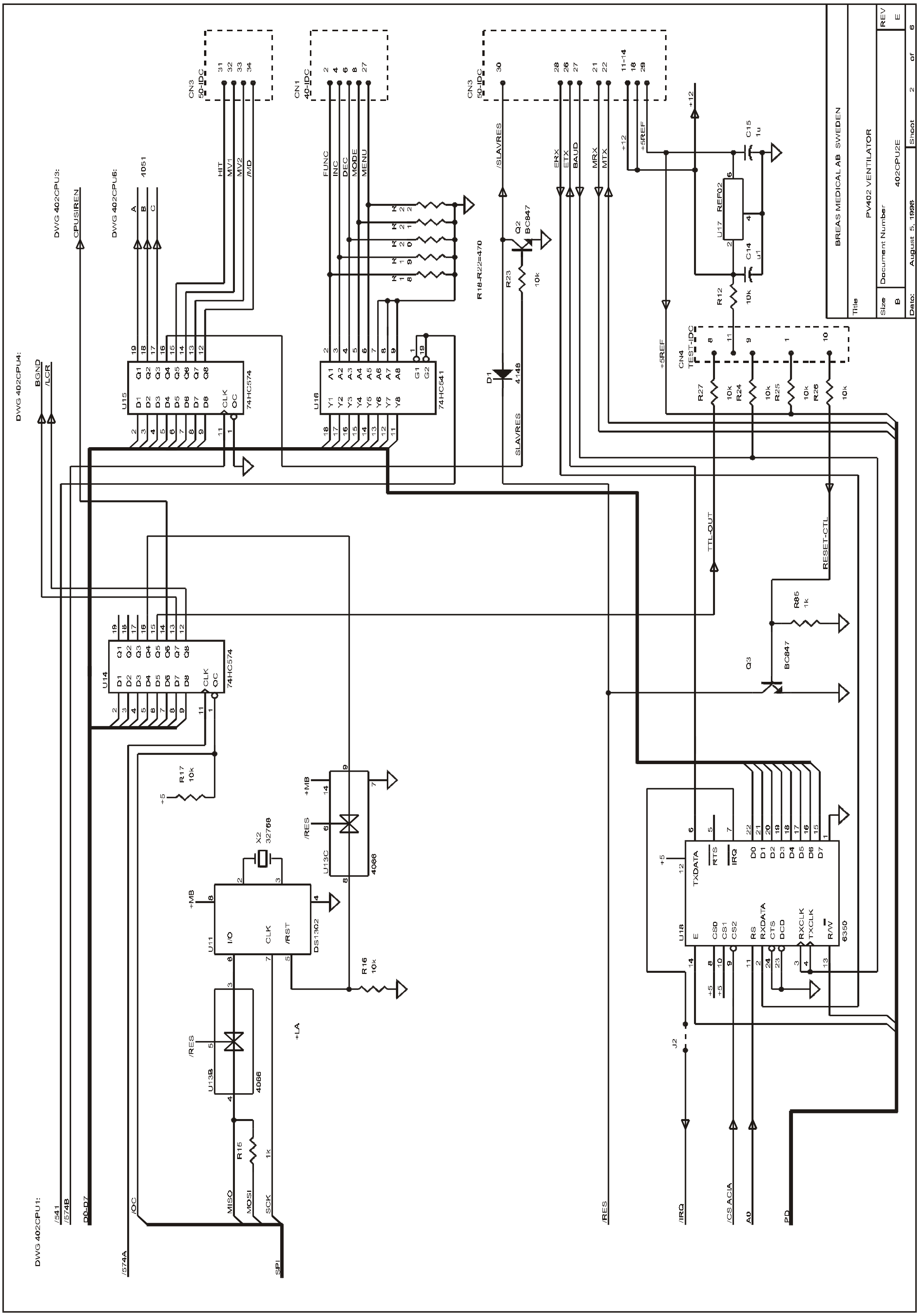
Limit value:	SFC	< 5mA

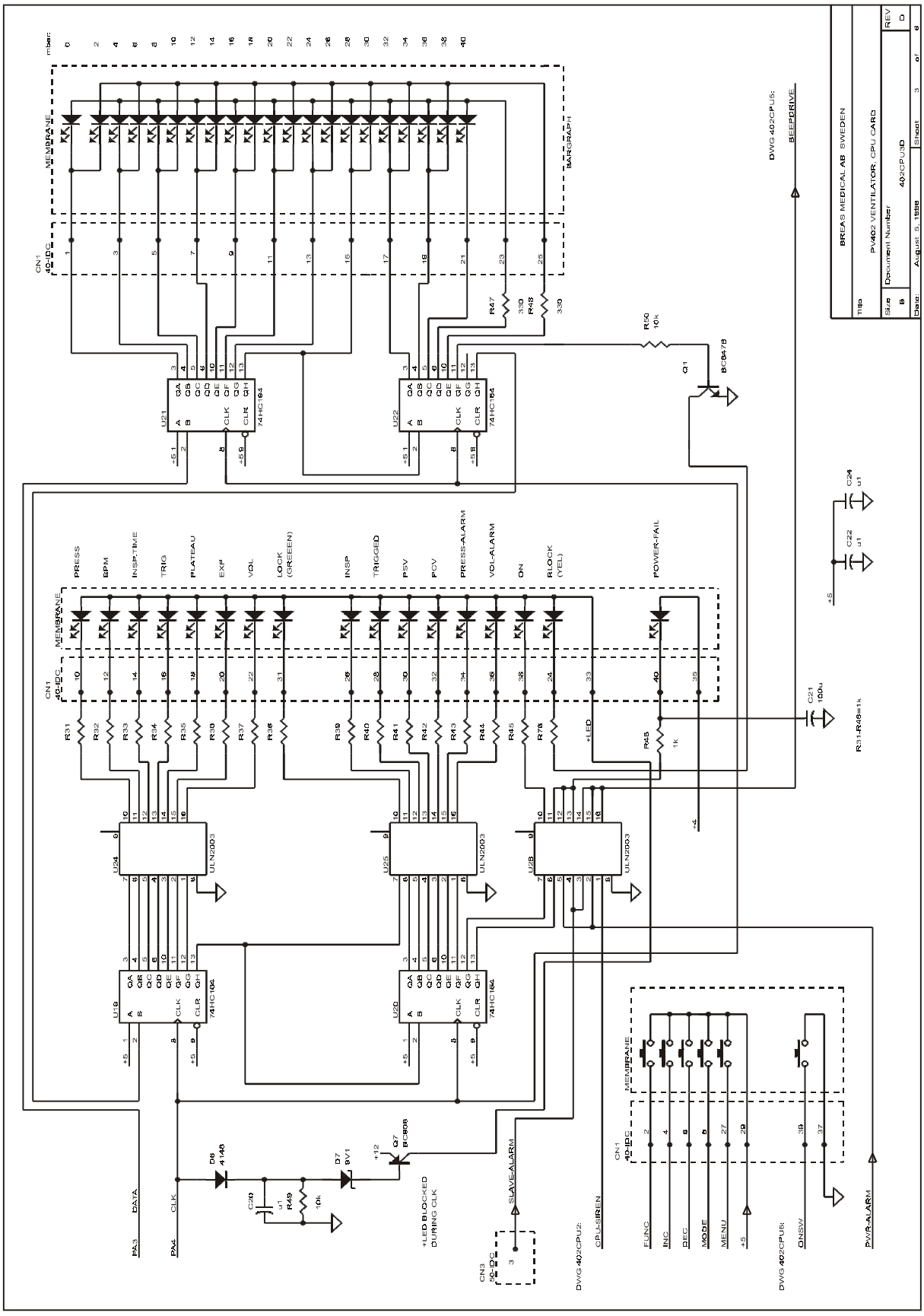
8.13 Circuit diagrams

8.13.1 CPU boards






BREAS MEDICAL AB SWEDEN
PV402 VENTILATOR
402CPU2E


MEMBRANE
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PRESS-ALARM
VOL-ALARM
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BLOCK (YEL)
POWER-FAIL
ULN2003
74HC164
BC848
BC808
DATA
CLK
SLAVE-ALARM
BEEPDRIVE
PWR-ALARM
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MODE
MENU
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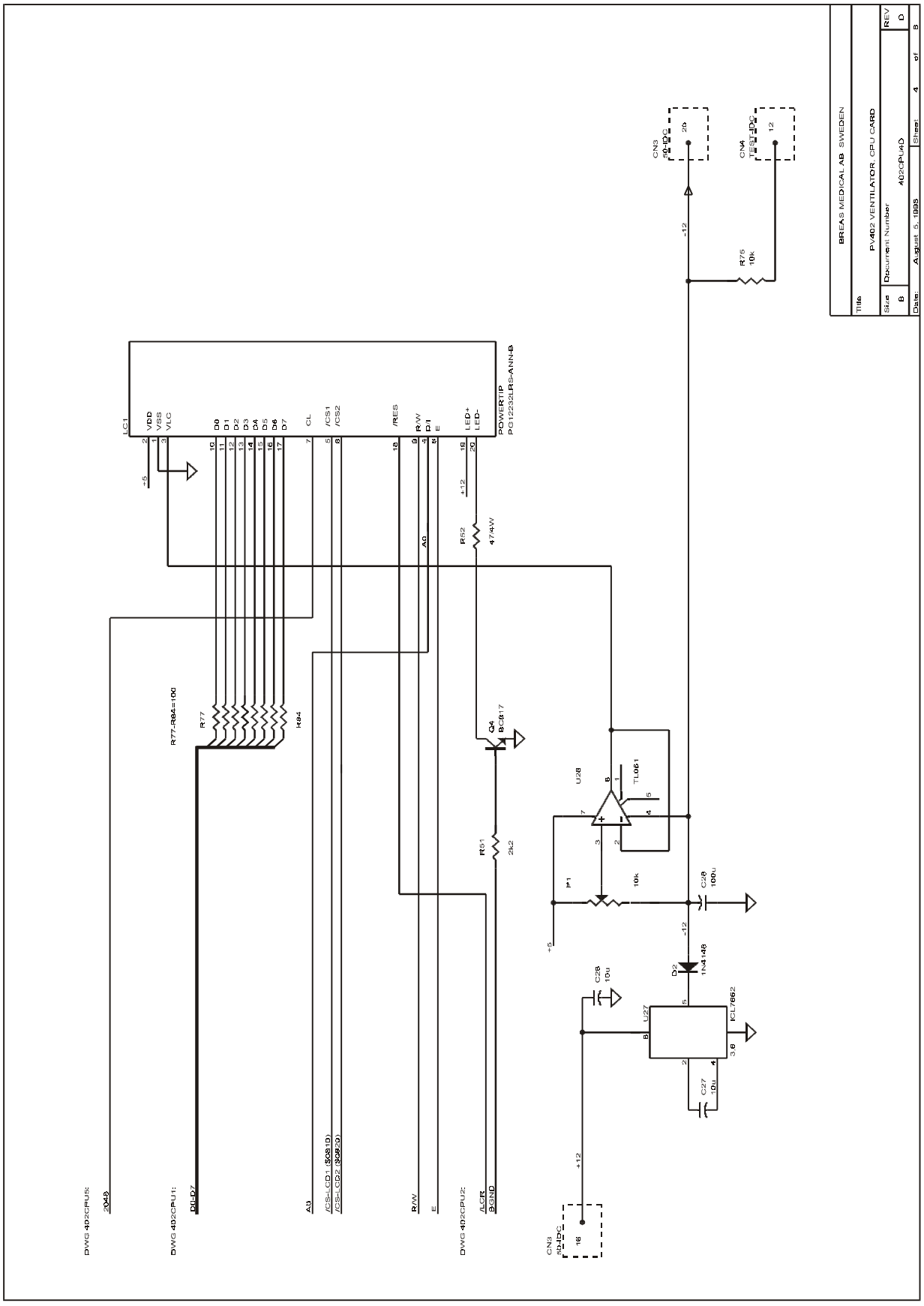
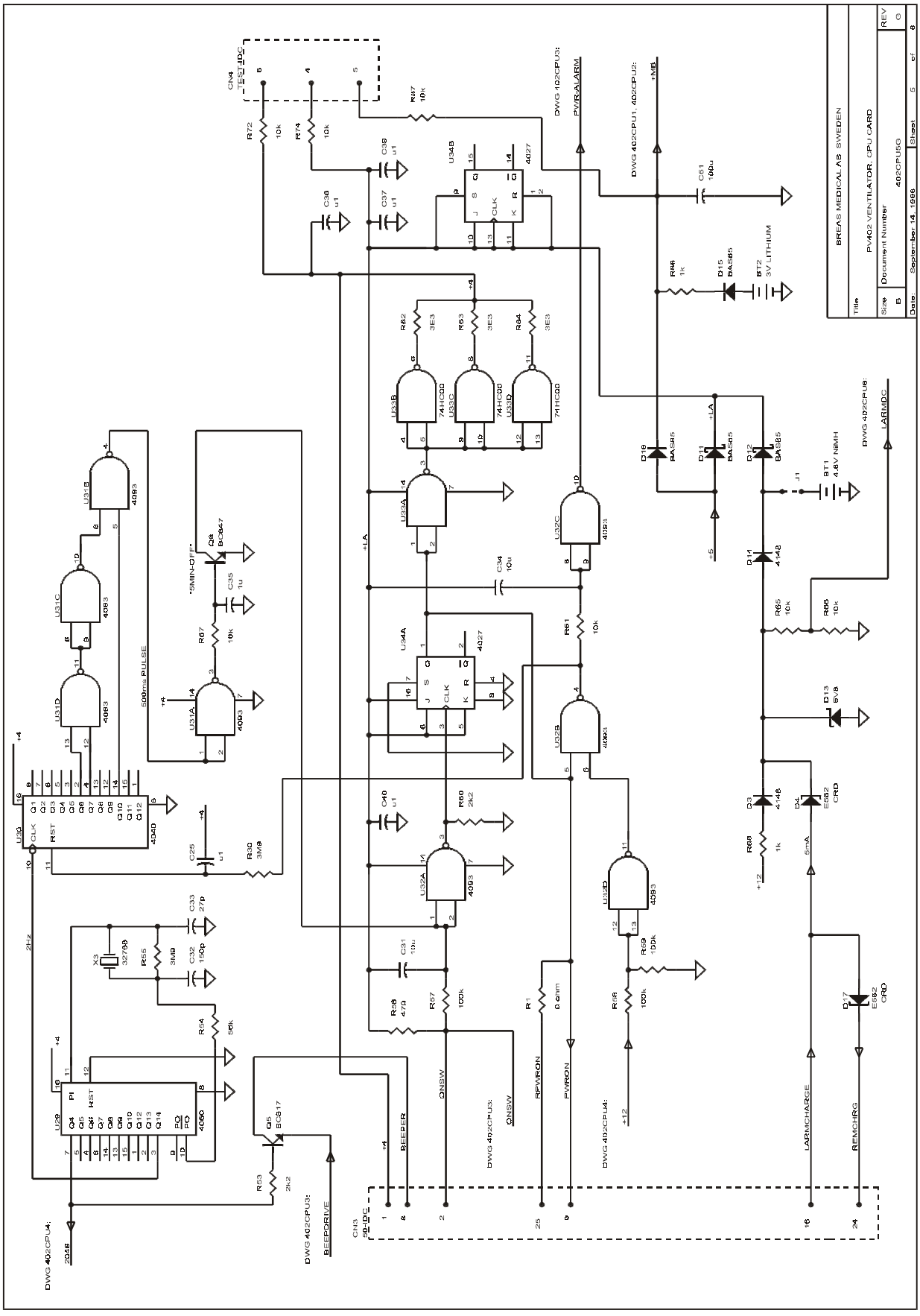
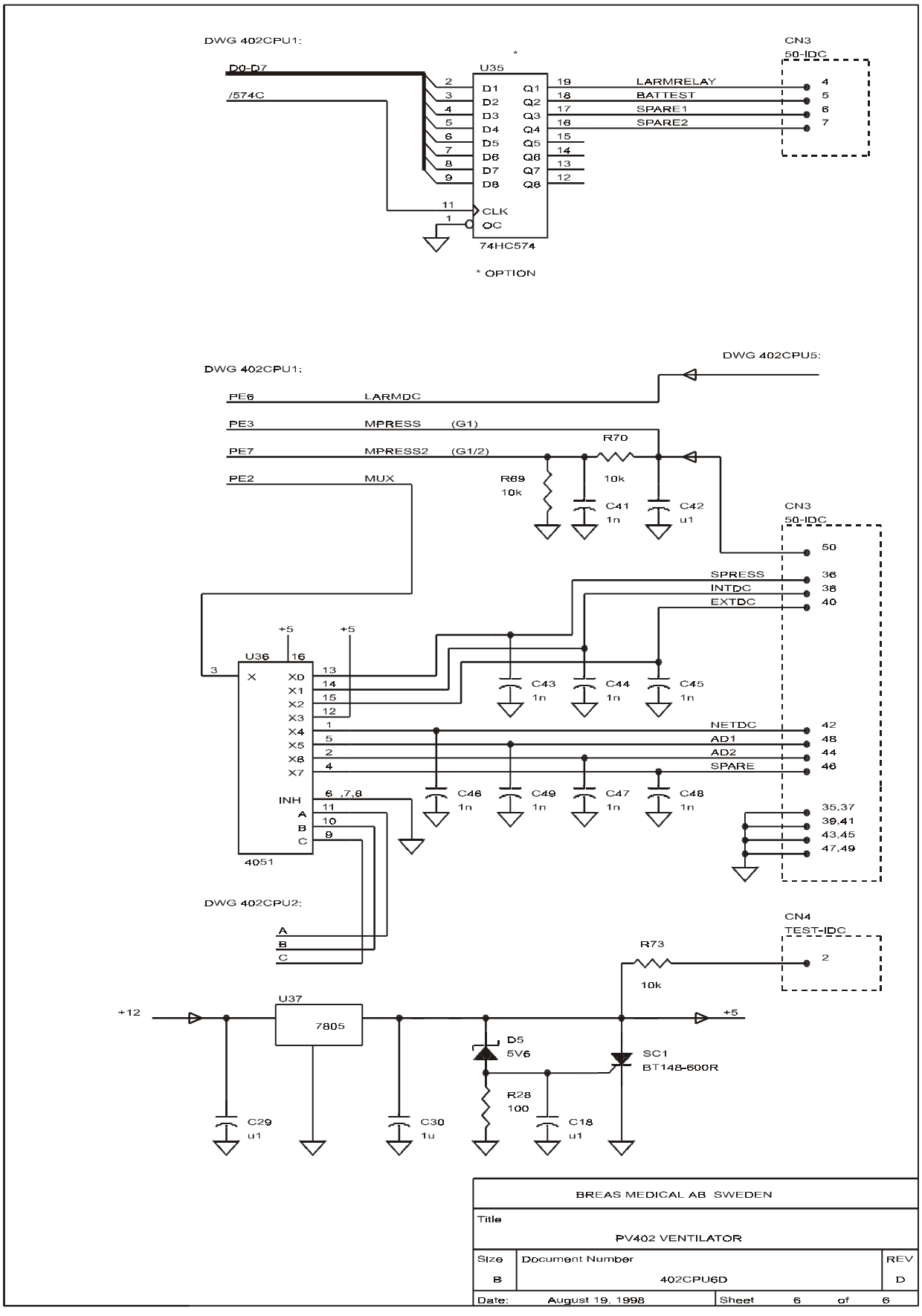
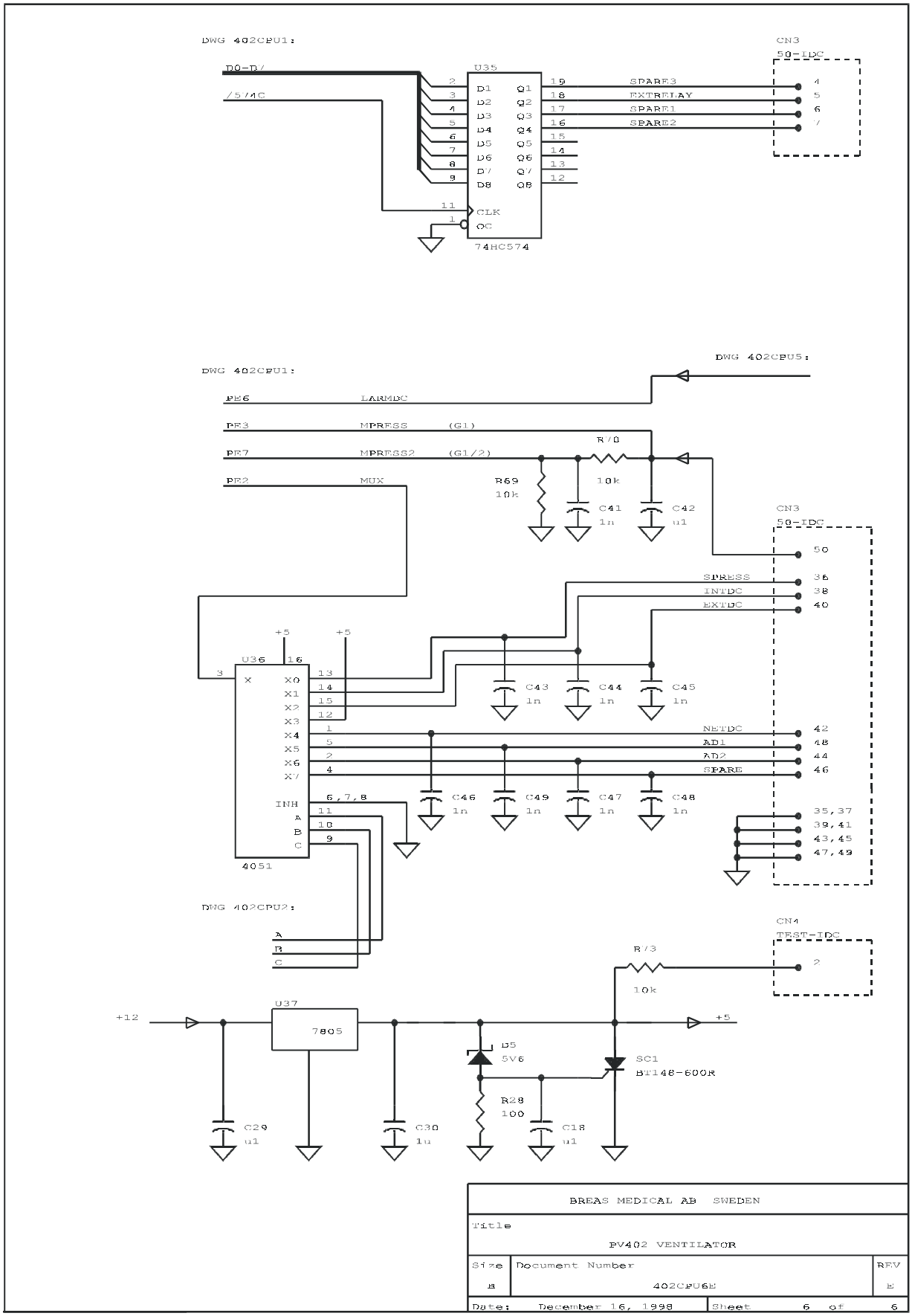
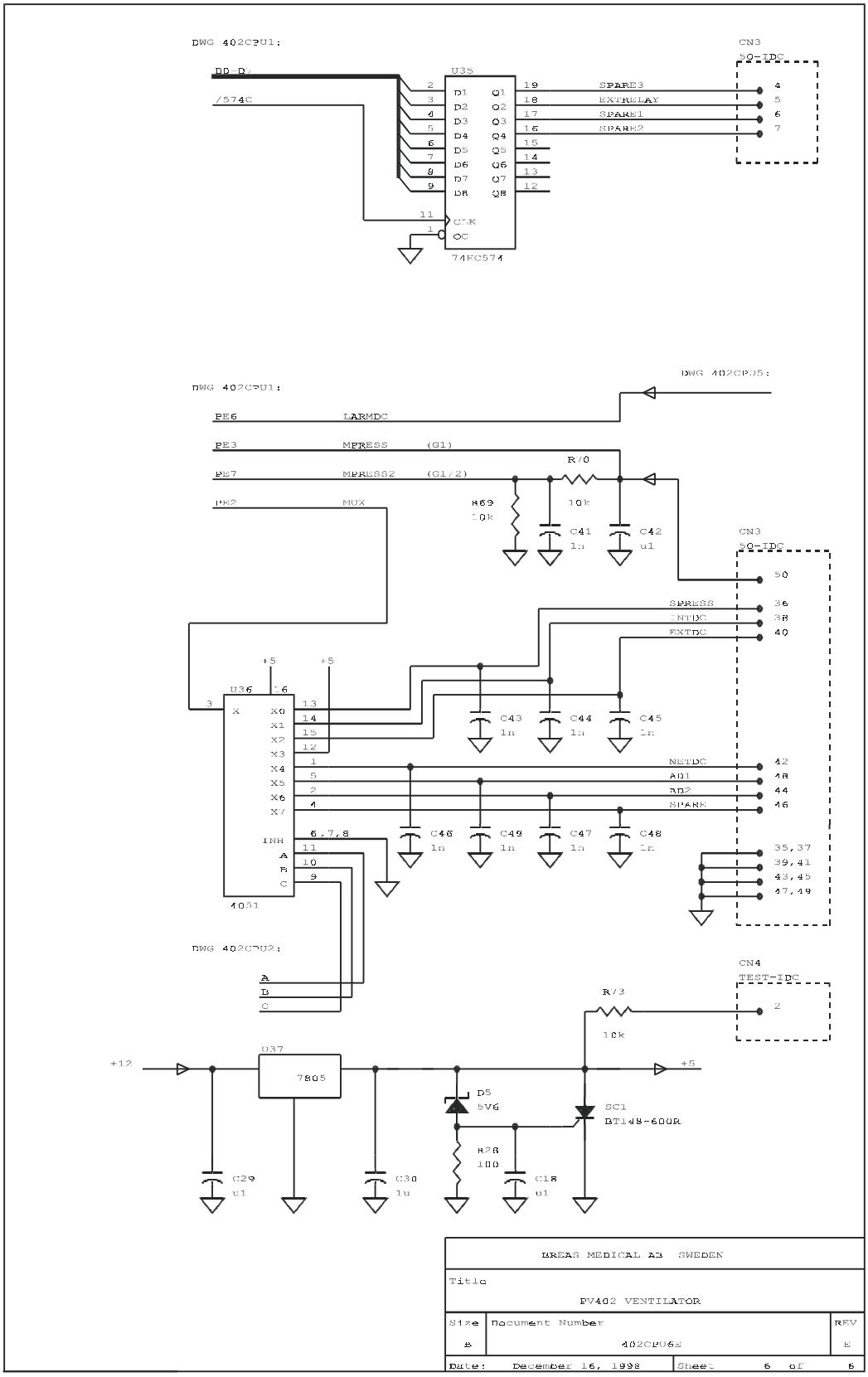
BREAS MEDICAL AB SWEDEN
PV402 VENTILATOR, CPU CARD


BREAS MEDICAL AB SWEDEN
PV402 VENTILATOR, CPU CARD
402CPU4D
August 5, 1998
LC1
POWERTIP
PG12232LRS-ANN-B
VDD
VSS
VLG
D0
D1
D2
D3
D4
D5
D6
D7
CL
/CS1
/CS2
/RES
R/W
DI
E
LED+
LED-
R77-R84=10Ω
R77
R84
R52
47/4W
Q4
BC817
R51
2k2
U28
TL081
P1
10k
C28
100u
D2
1N4148
U27
KCL7662
C27
10u
CN3
CN4
TEST-IPC
DWG 402CPU5:
DWG 402CPU1:
DWG 402CPU2:
/CS-LCD1 (508:1D)
/CS-LCD2 (508:2D)

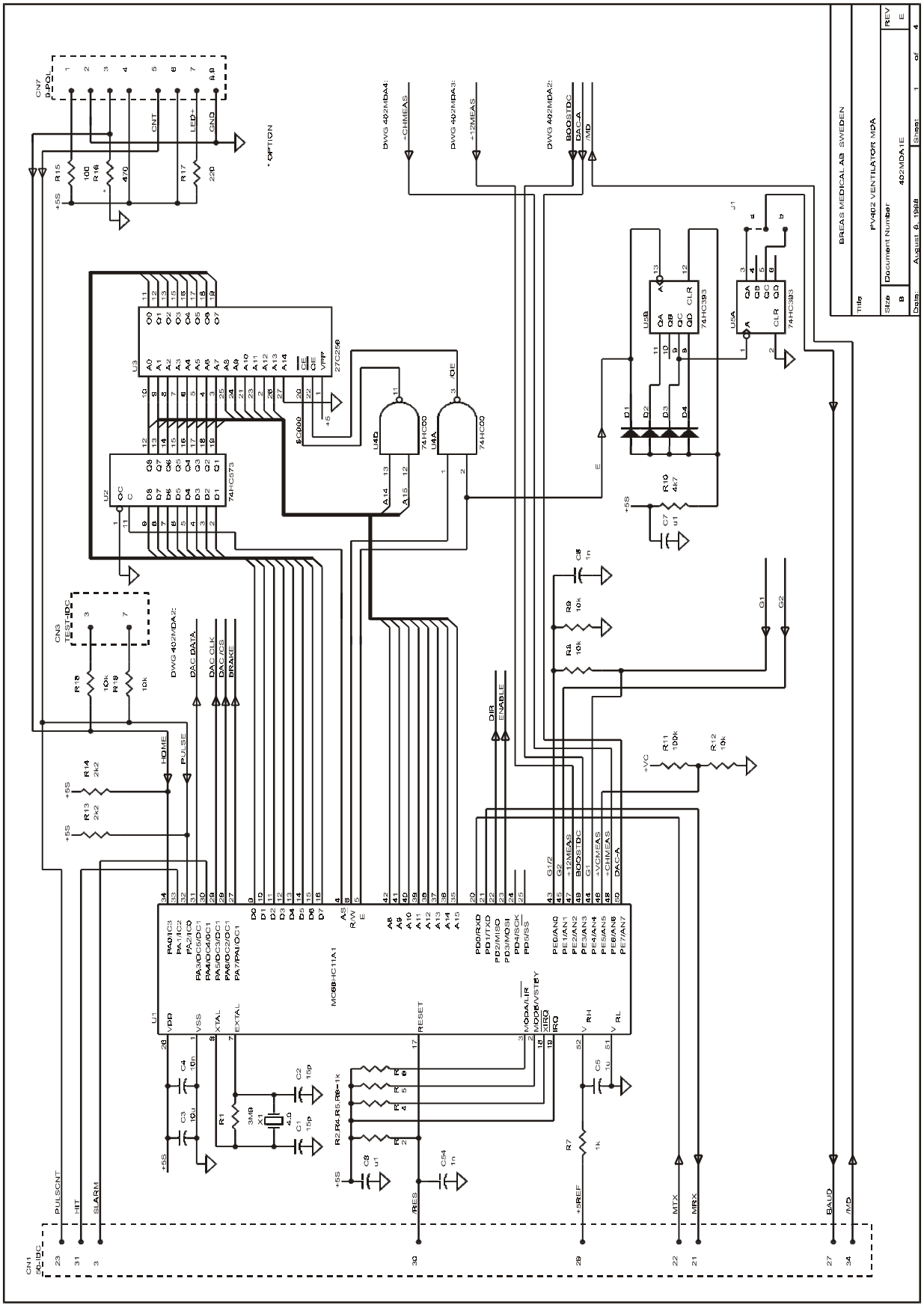

BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR, CPU CARD
Size B
Document Number 402CPU5G
REV C
Date: September 14, 1998
Sheet 5 of 8
CN4 TEST IDC
CN3 50-IDC
DWG 402CPU3: PWR-ALARM
DWG 402CPU1, 402CPU2: +VB
DWG 402CPU4: 2048
DWG 402CPU3: BEEPDRIVE
DWG 402CPU3: QNSW
DWG 402CPU4: +12
DWG 402CPU3: RPWRON
DWG 402CPU3: FPWRON
DWG 402CPU8: LARMDC
LARMCHARGE
REMCHRG
5MIN-OFF
500ms PULSE
BEEPER
QNSW
RPWRON
FPWRON
2Hz
+LA
+5
+12
+4
BT1 4.8V NiMH
BT2 3V LITHIUM

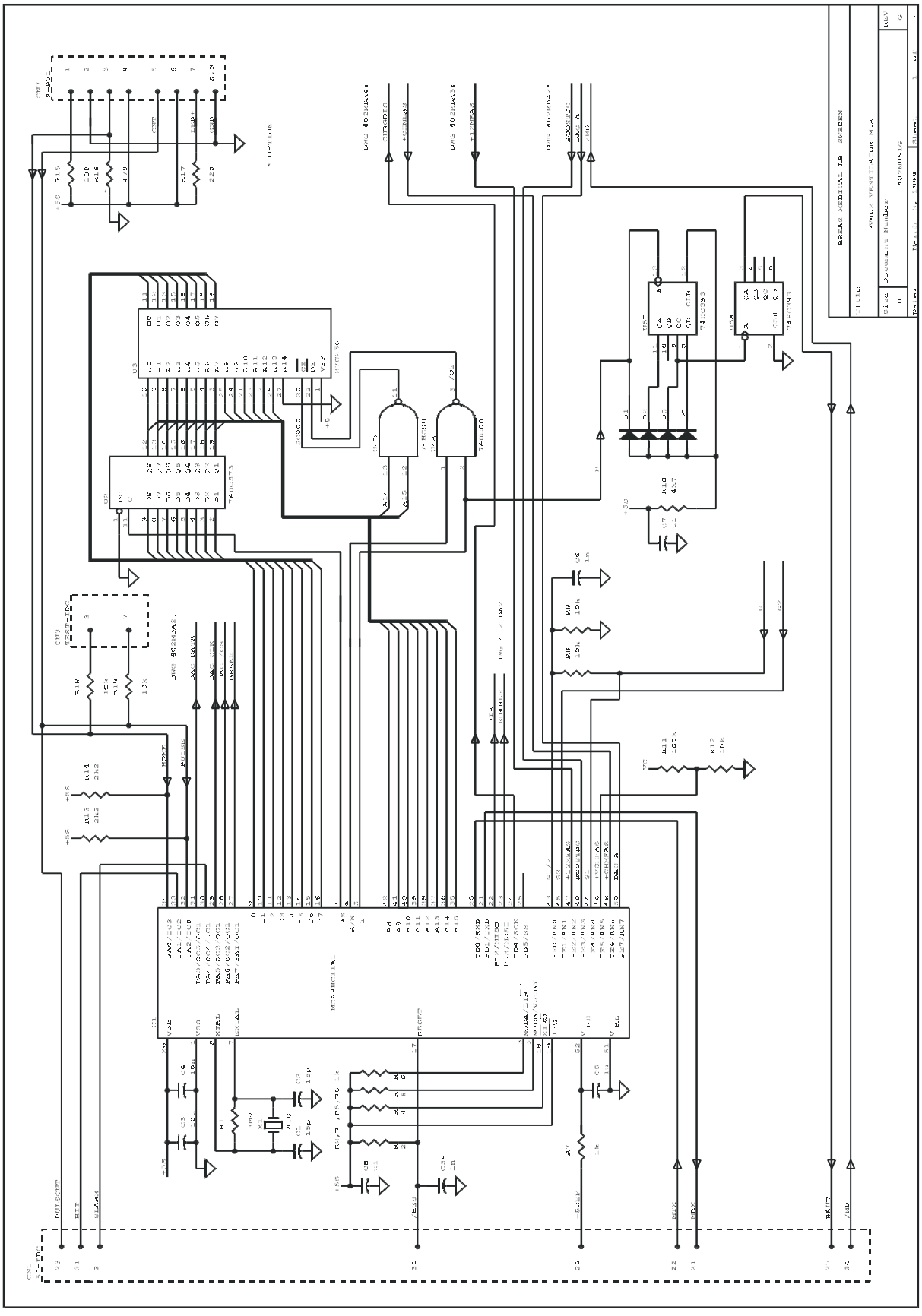

DWG 402CPU1:
D0-D7
/574C
U35
74HC574
CLK
OC
LARMRELAY
BATTEST
SPARE1
SPARE2
CN3
50-IDC
* OPTION
DWG 402CPU5:
PE6 LARMDC
PE3 MPRESS (G1)
PE7 MPRESS2 (G1/2)
PE2 MUX
R70
R89
10k
C41
1n
C42
u1
SPRESS
INTDC
EXTDC
U36
4051
C43
C44
C45
C46
C49
C47
C48
NETDC
AD1
AD2
SPARE
INH
DWG 402CPU2:
CN4
TEST-IDC
R73
U37
7805
+12
+5
D5
5V6
SC1
BT148-600R
R28
100
C29
C30
1u
C18
BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR
Size
B
Document Number
402CPU6D
REV
D
Date: August 19, 1998
Sheet 6 of 6

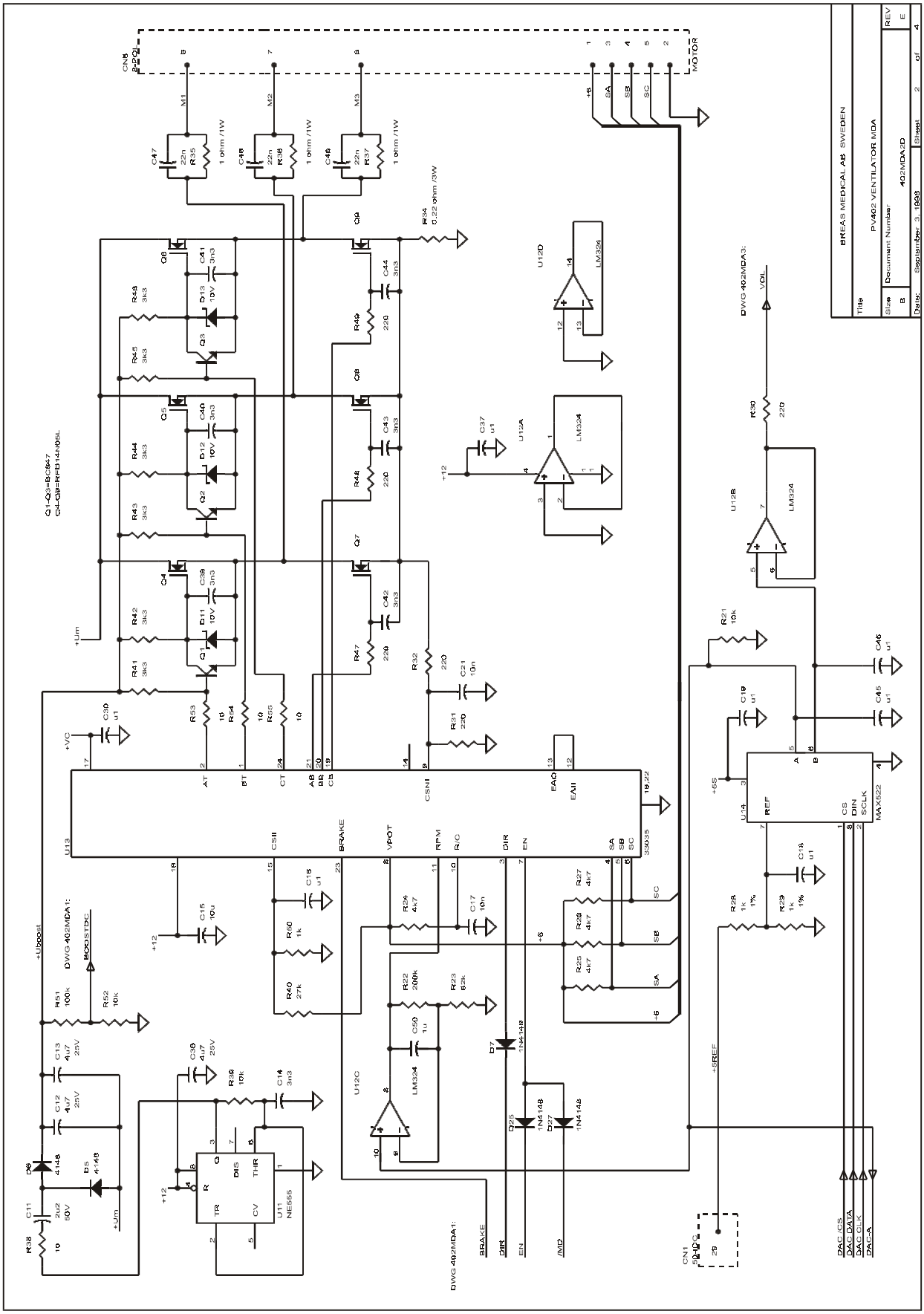

DWG 402CPU1:
D0-D7
/STAC
U35
D1 Q1
D2 Q2
D3 Q3
D4 Q4
D5 Q5
D6 Q6
D7 Q7
D8 Q8
CLK
OC
74HC574
SPARE3
EXTRELAY
SPARE1
SPARE2
CN3
50-IDC
DWG 402CPU5:
PE6 LARMDC
PE3 MPRESS (G1)
PE7 MPRESS2 (G1/2)
PE2 MUX
R70
10k
R69
10k
C41
1n
C42
u1
SPRESS
INTDC
EXTDC
U36
4051
X0
X1
X2
X3
X4
X5
X6
X7
INH
A
B
C
C43
1n
C44
1n
C45
1n
C46
1n
C49
1n
C47
1n
C48
1n
NETDC
AD1
AD2
SPARE
DWG 402CPU2:
CN4
TEST-IDC
R73
10k
U37
7805
+12
+5
D5
5V6
SC1
BT148-600R
R28
100
C29
u1
C30
1u
C18
u1
BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR
Size
B
Document Number
402CPU6E
REV
E
Date: December 16, 1998
Sheet 6 of 6

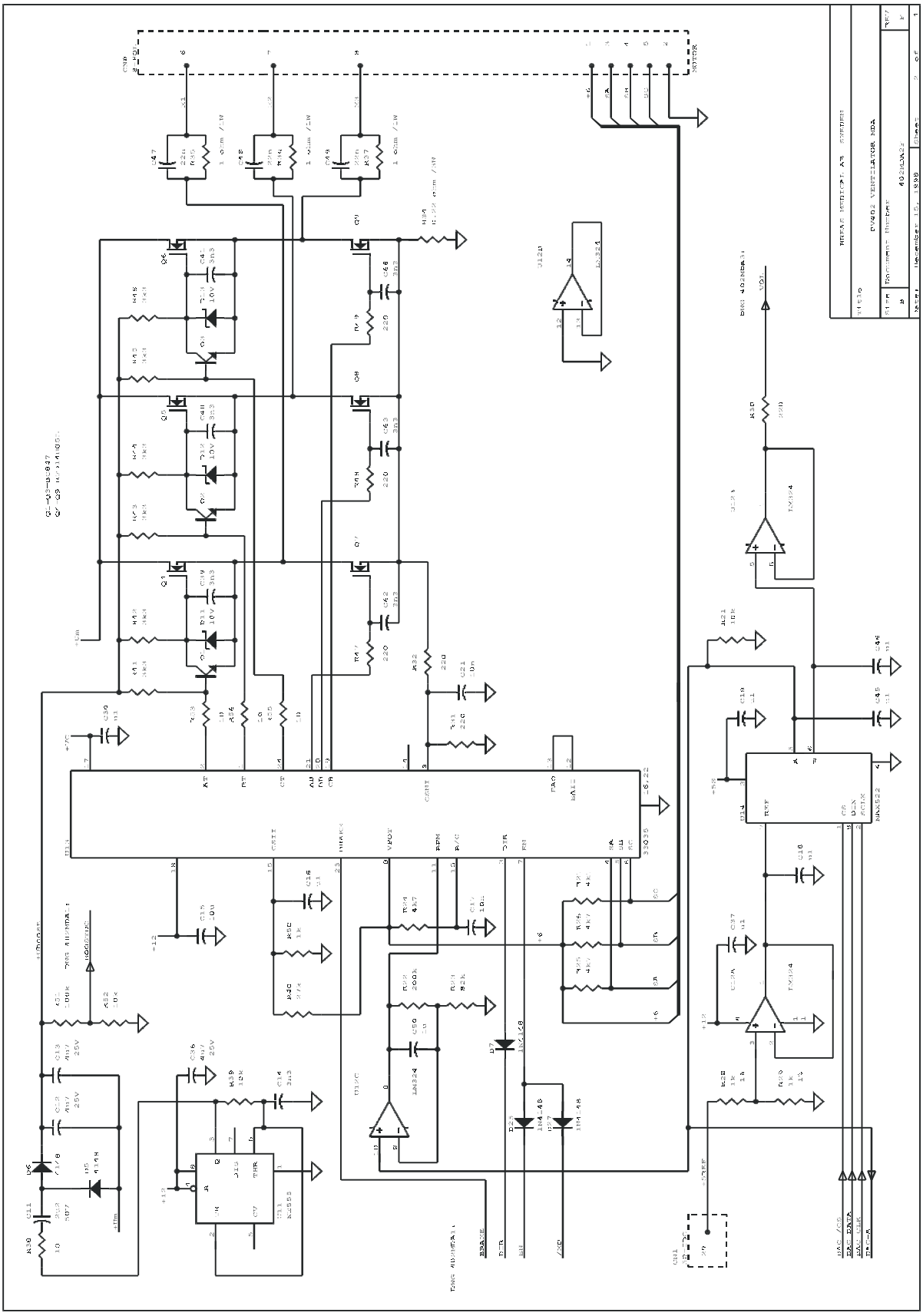

DWG 402C2U1:
DB-D/
/574C
U35
74HC574
SPARE3
EXTRELAY
SPARE1
SPARE2
CN3
50-IDC
DWG 402C2U1:
PE6 LARMDC
PE3 MPRESS (G1)
PE7 MPRES82 (G1/2)
PH2 MUX
R69 10k
R70 10k
C41 1n
C42 u1
SPRESS
INTDC
EXTDC
U36
4051
C43 1n
C44 1n
C45 1n
NETDC
AD1
AD2
SPARE
C46 1n
C49 1n
C47 1n
C48 1n
35,37
39,41
43,45
47,49
DWG 402C2U2:
A
B
C
CN4
TEST-IDC
R73 10k
U37
7805
+12
+5
D5 5V6
SC1 BT148-600R
R28 100
C29 u1
C30 1u
C18 u1
BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR
Size A
Document Number 402CPU6B
REV B
Date: December 16, 1998
Sheet 6 of 8

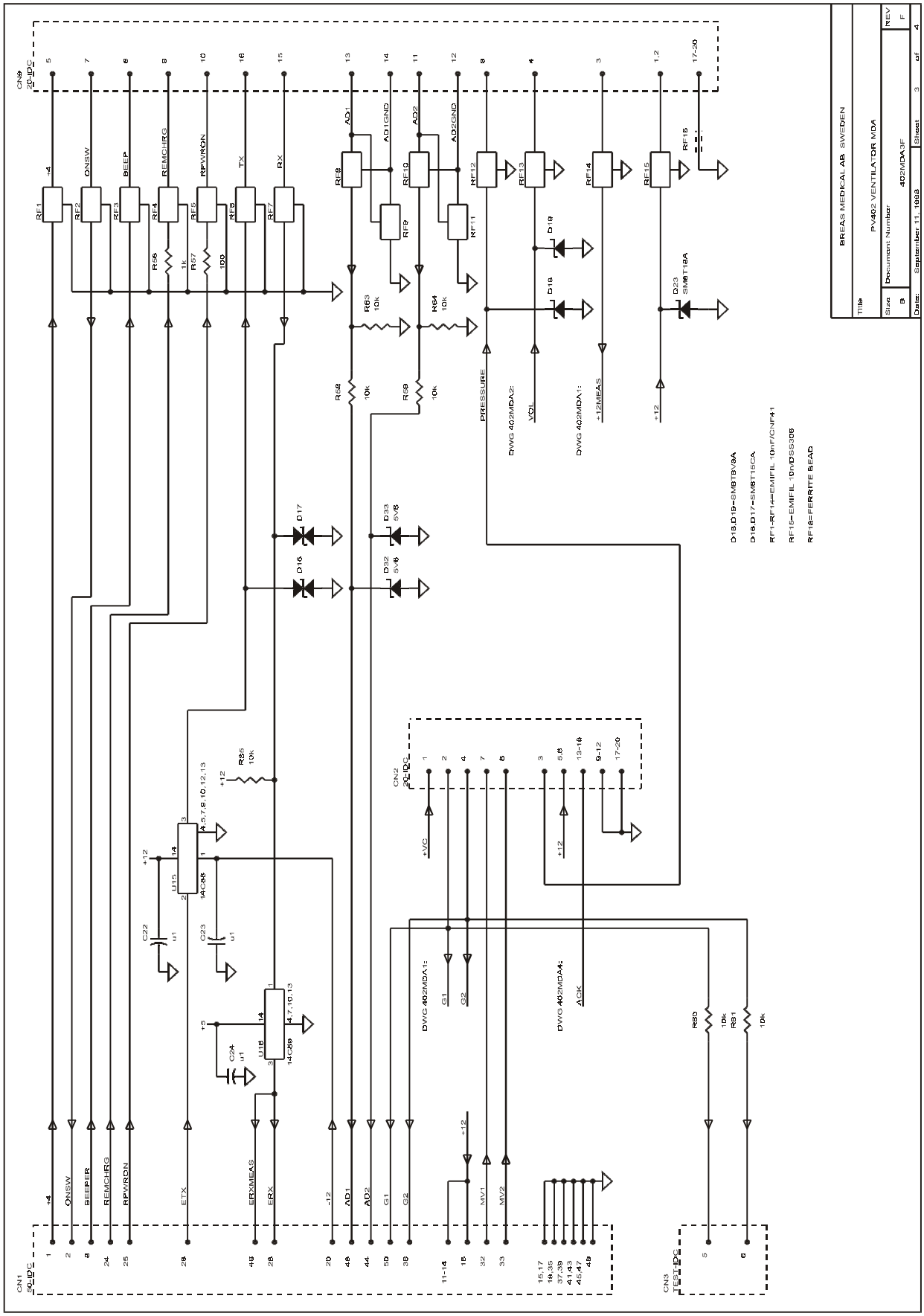
8.13.2 MDA boards

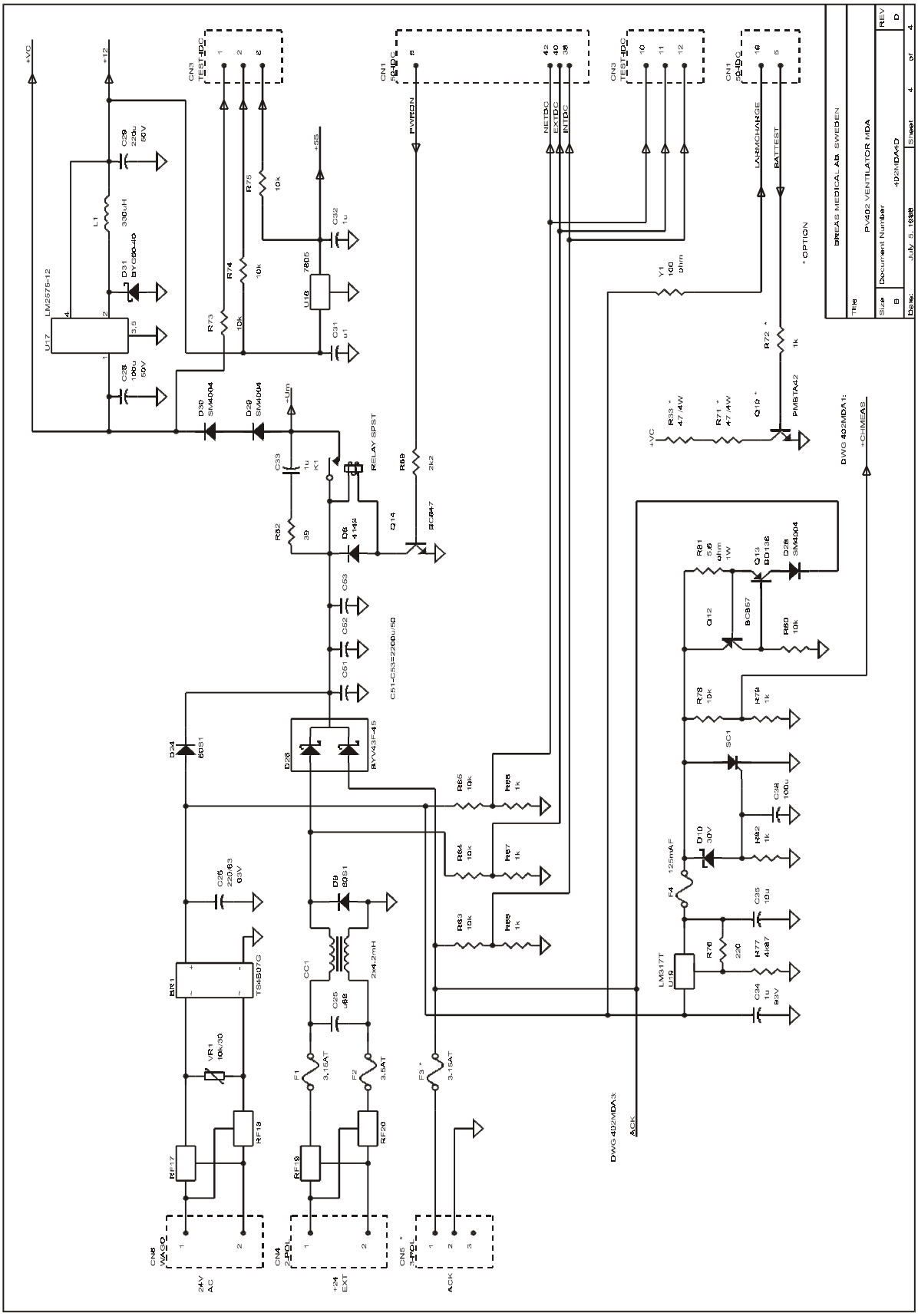


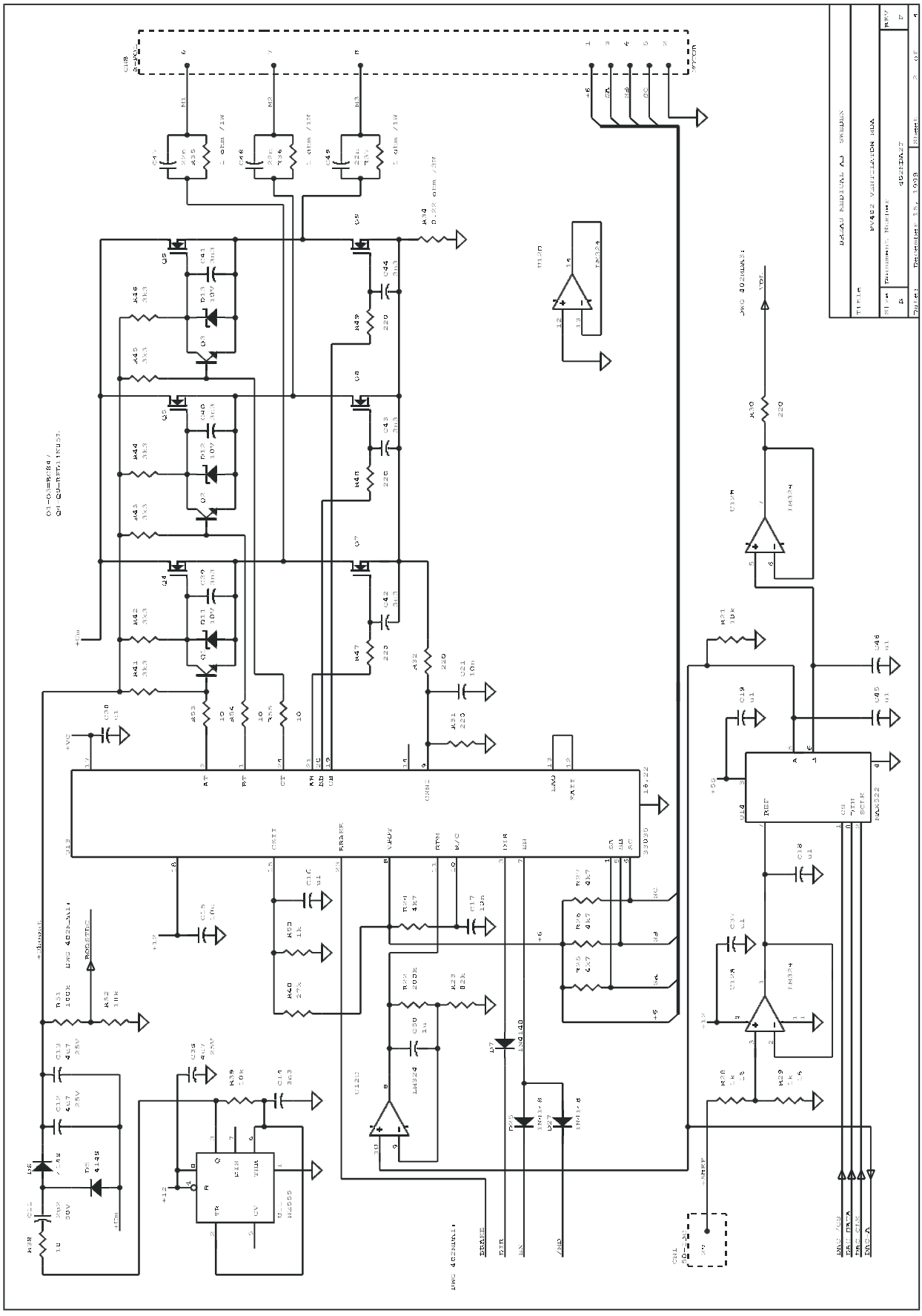



BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR MDA
Size
B
Document Number
402MDA3D
REV
E
Date:
September 3, 1998
Sheet
2
of
4
MOTOR
M1
M2
M3
1 ohm /1W
R34
0.22 ohm /3W
Q1-Q3=BC847
Q4-Q9=IRFD114/D6L
LM324
U12A
U12B
U12C
U12D
U13
U14
MAX522
NE555
U11
+Um
+Uboost
+VC
+12
+6
+5S
+5REF
BLOCKSTDC
BRAKE
DIR
EN
AMD
DAC-CS
DAC-DATA
DAC-CLK
DAC-A
DWG 402MDA1:
DWG 402MDA3:
CN1
CN5

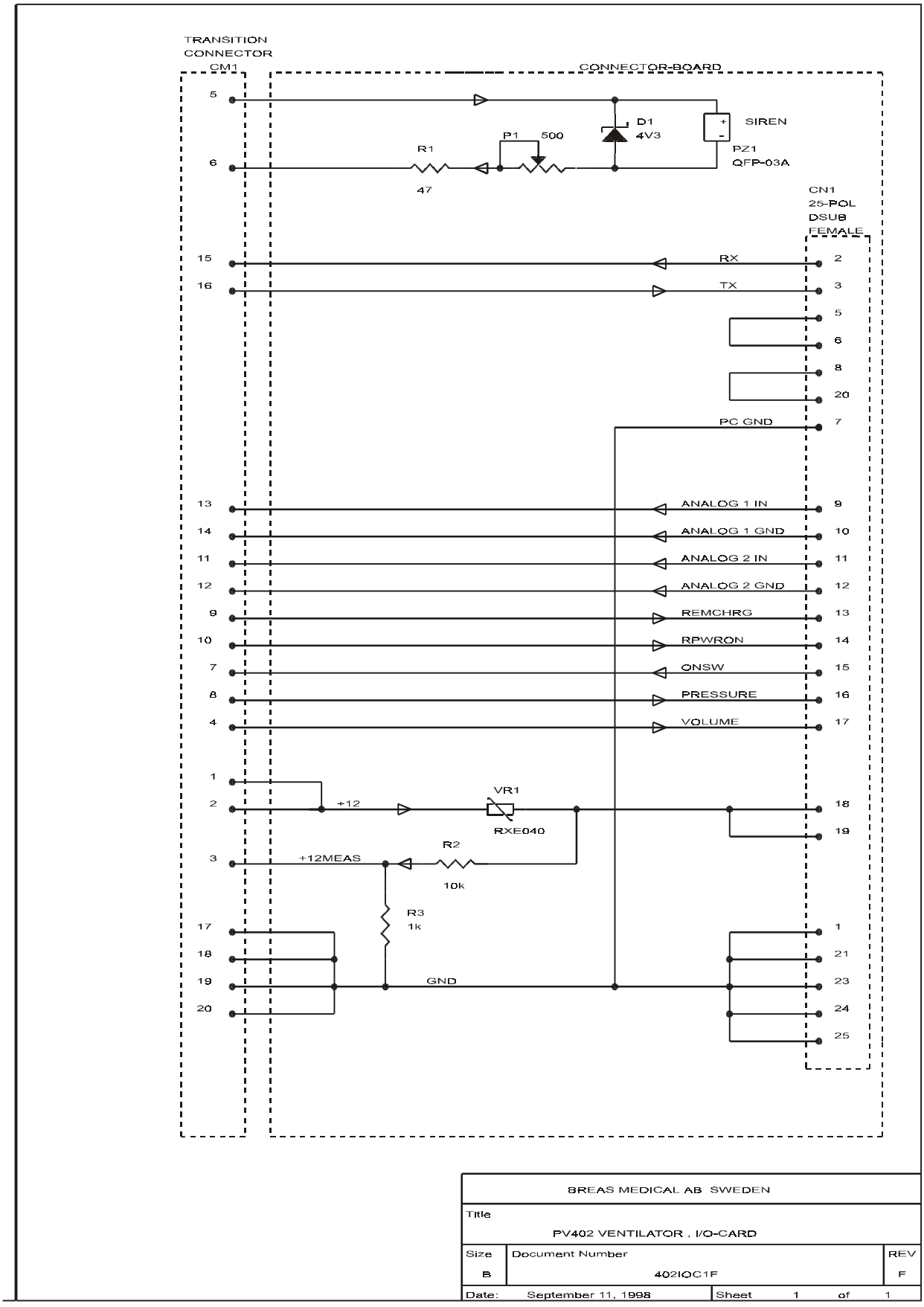



BREAS MEDICAL AB SWEDEN
PV402 VENTILATOR MDA
402MDA3F
September 11, 1998
D18,D19=SMBTB9A
D16,D17=SMBT15CA
RF1-RF14=EMIFIL 10nF/CNF41
RF15=EMIFIL 10nF/DSS308
RF16=FERRITE BEAD

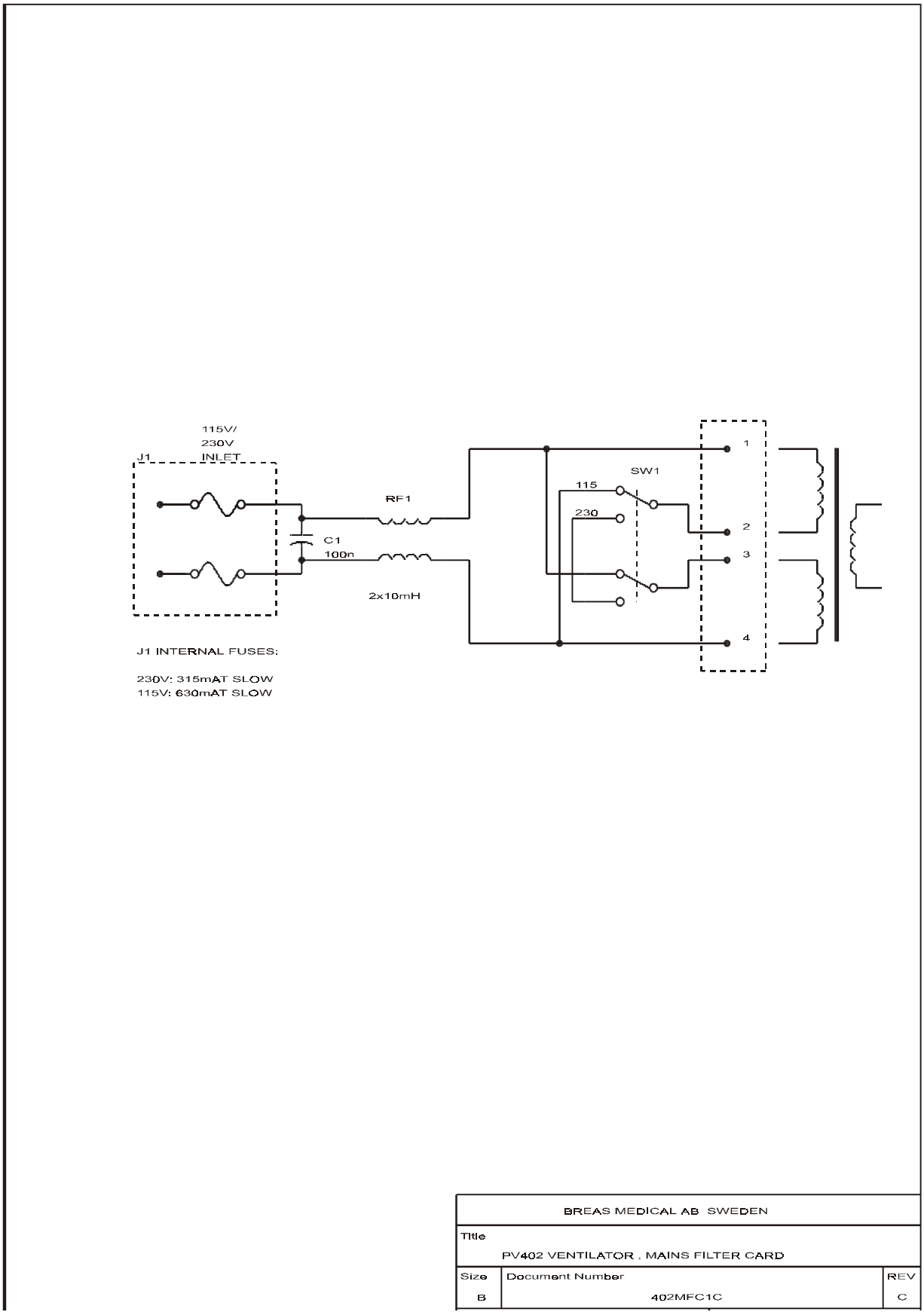

BREAS MEDICAL AB, SWEDEN
PV402 VENTILATOR MDA
Document Number
402MDA4D
July 5, 1998
Sheet 4 of 4
REV D
Size B
Title
+VC
+12
+5S
+Um
+OPTION
PWRGN
NETDC
EXTDC
INTDC
LARMCHANGE
BATTEST
+CHMEAS
DWG 402MDA1:
DWG 402MDA3:
ACK
RELAY SPST
C51-C53=2200u/50
LM2575-12
LM317T
TSHB07G
BYV43F-45
BCP54-7
BCB57
BD136
PMBTA42
TEST-IDC
CN1
CN3
CN4
CN5 *
CN6
2-POL
3-POL
24V AC
+24 EXT
ACK



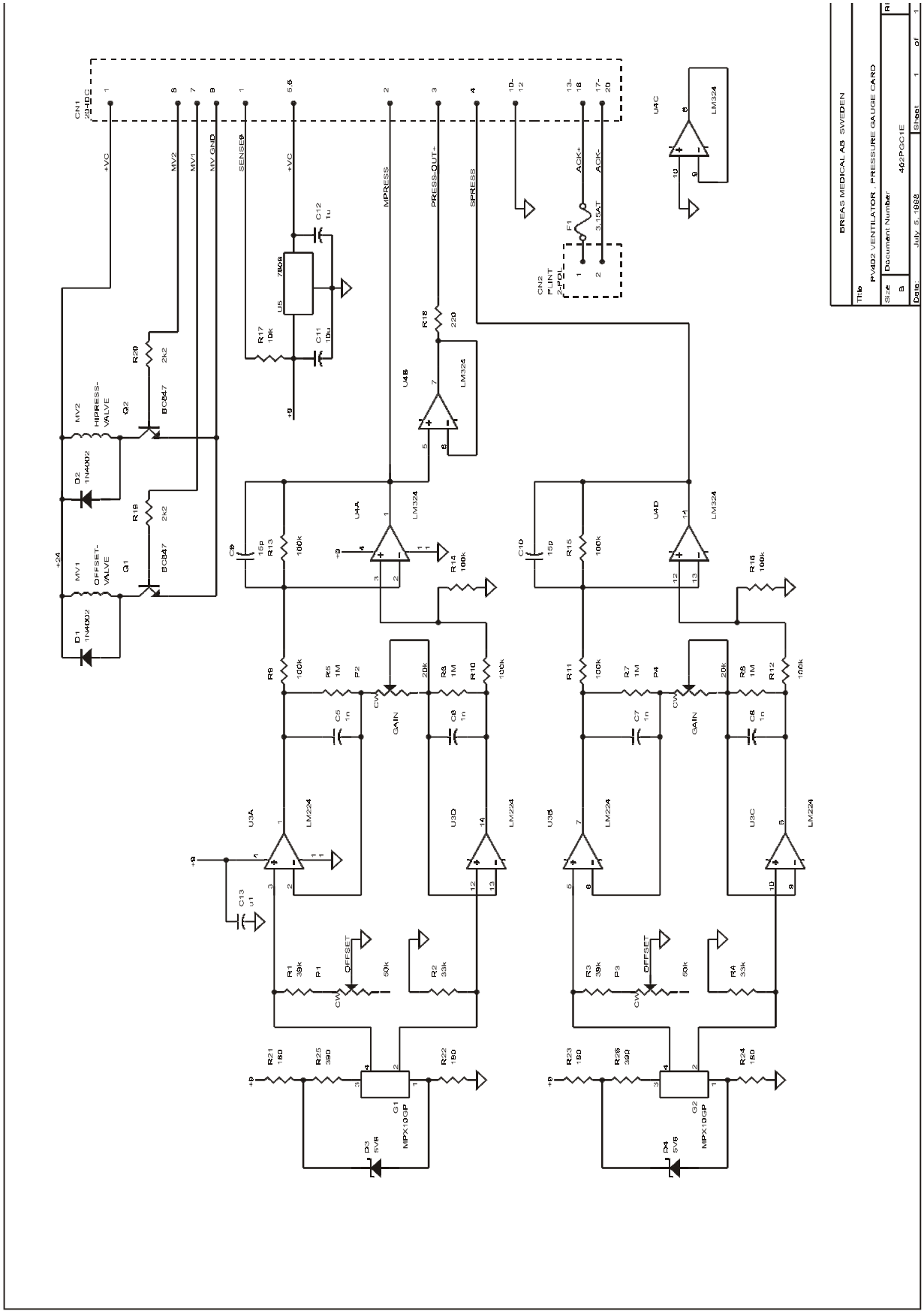
8.13.3 I/O


TRANSITION
CONNECTOR
CM1
CONNECTOR-BOARD
5
6
D1
4V3
SIREN
PZ1
QFP-03A
P1
500
R1
47
CN1
25-POL
DSUB
FEMALE
15
16
RX
TX
2
3
5
6
8
20
PC GND
7
13
14
11
12
9
10
7
8
4
ANALOG 1 IN
ANALOG 1 GND
ANALOG 2 IN
ANALOG 2 GND
REMCHRG
RPWRON
ONSW
PRESSURE
VOLUME
9
10
11
12
13
14
15
16
17
1
2
3
+12
VR1
RXE040
18
19
+12MEAS
R2
10k
R3
1k
17
18
19
20
GND
1
21
23
24
25
BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR , I/O-CARD
Size
B
Document Number
402IOC1F
REV
F
Date: September 11, 1998
Sheet 1 of 1

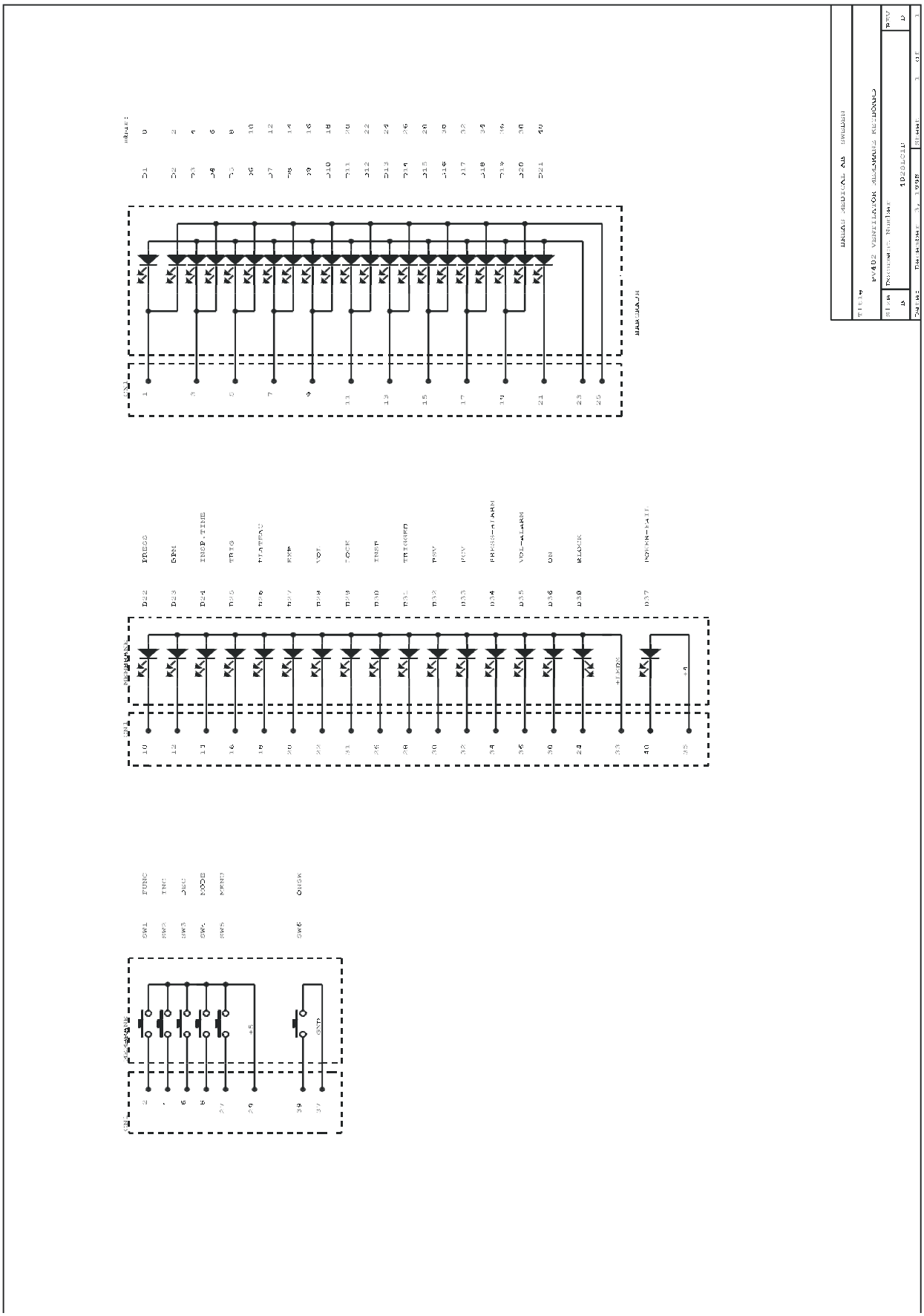
8.13.4 MFC


115V/
230V
INLET
J1
RF1
C1
100n
2x10mH
SW1
115
230
1
2
3
4
J1 INTERNAL FUSES:
230V: 315mAT SLOW
115V: 630mAT SLOW
BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR , MAINS FILTER CARD
Size
B
Document Number
402MFC1C
REV
C

8.13.5 PGC

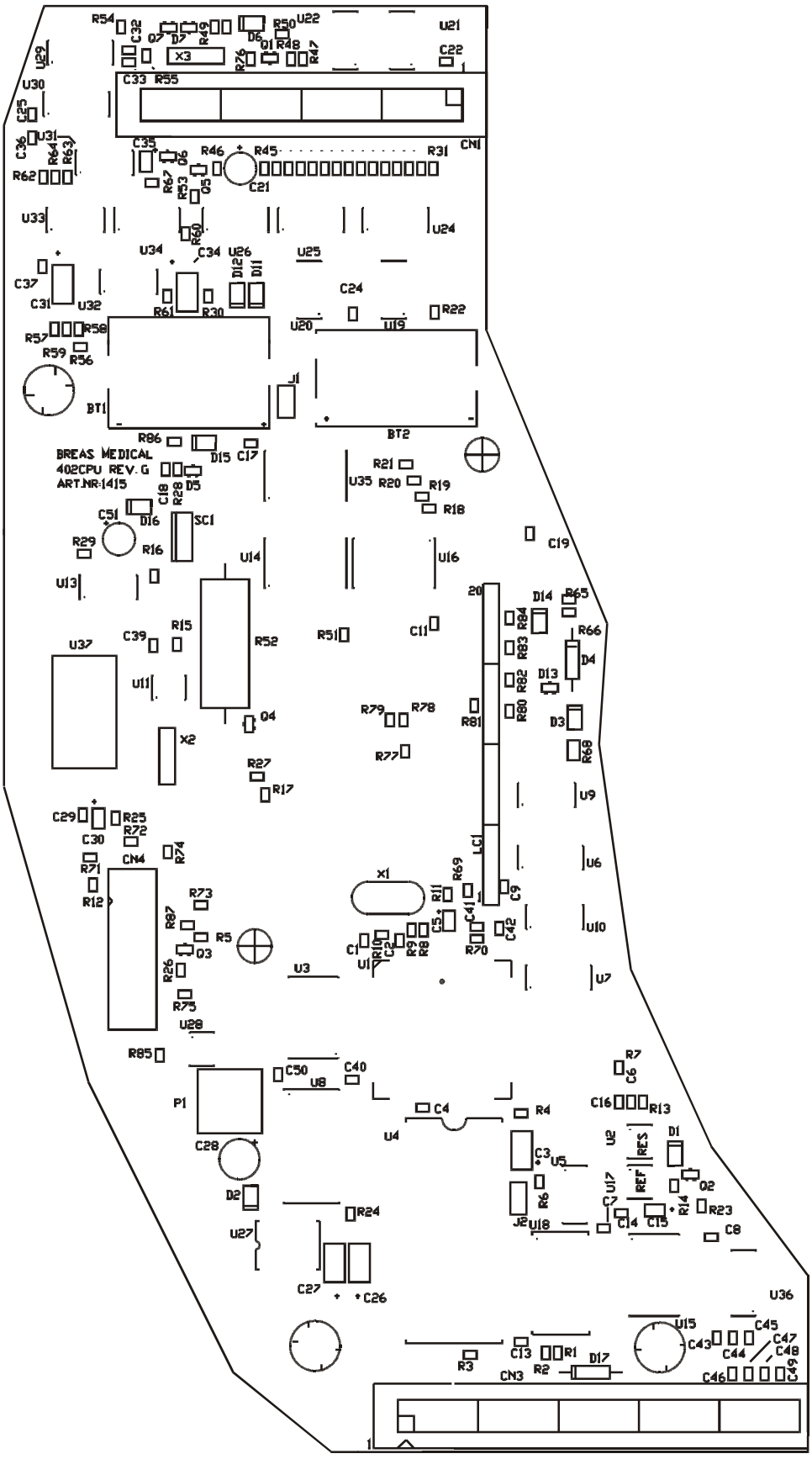

BREAS MEDICAL AB SWEDEN
Title
PV402 VENTILATOR PRESSURE GAUGE CARD
Size
B
Document Number
402PGC1E
Rev
A
Date:
July 5, 1998
Sheet
1
of
1
CN1
+VC
MV2
MV1
MV GND
SENSE
MPRESS
PRESS-OUT+
SPRESS
ACK+
ACK-
CN2
PNT
PGC
F1
3.15AT
U4C
LM324
U5
7808
C12
1u
C11
10u
R17
10k
R18
220
U4B
LM324
MV2
MPRESS-
VALVE
Q2
BC847
R20
2k2
D2
1N4002
MV1
OFFSET-
VALVE
Q1
BC847
R19
2k2
D1
1N4002
+24
C9
15p
R13
100k
U4A
LM324
R14
100k
C10
15p
R15
100k
U4D
LM324
R16
100k
R6
100k
R5
1M
P2
20k
GAIN
R8
1M
R10
100k
C5
1n
C8
1n
R11
100k
R7
1M
P4
20k
GAIN
R9
1M
R12
100k
C7
1n
C8
1n
U3A
LM224
U3D
LM224
U3B
LM224
U3C
LM224
C13
u1
R1
39k
P1
50k
OFFSET
R2
33k
R3
39k
P3
50k
OFFSET
R4
33k
R21
180
R25
390
R22
180
G1
MPX10GP
P3
SV8
R23
180
R26
390
R24
180
G2
MPX10GP
P4
SV8

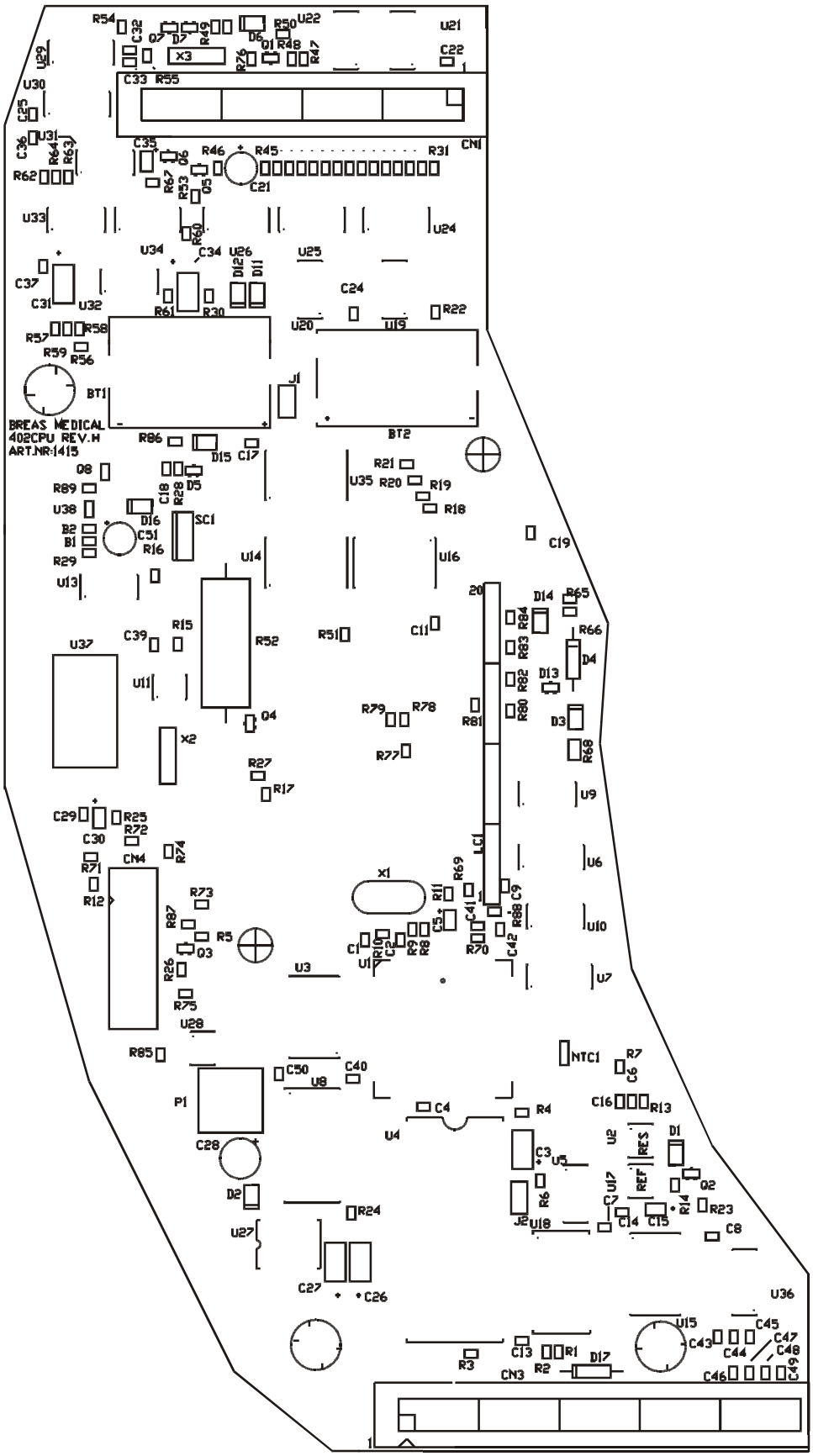
8.13.6 LCD



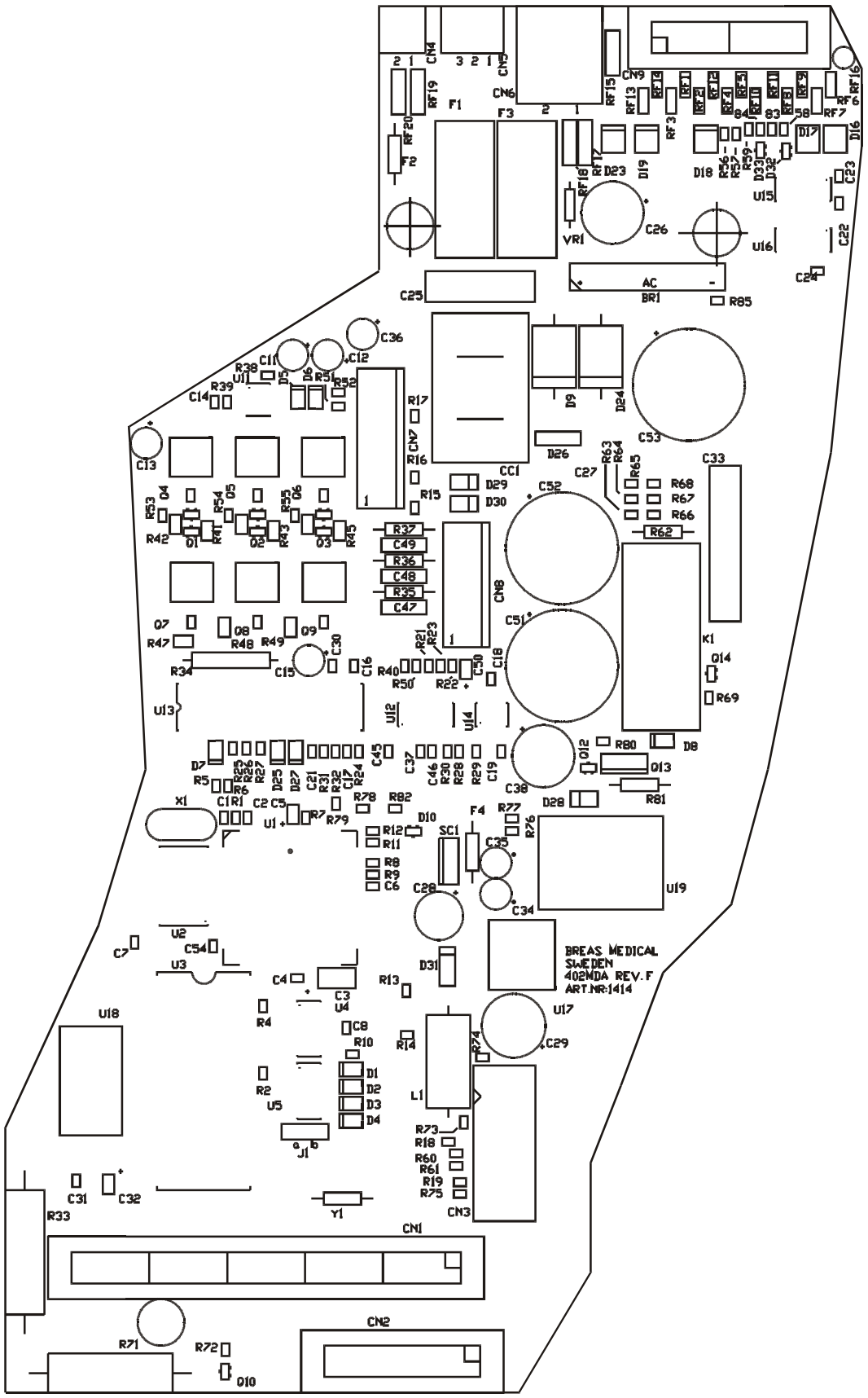
8.14 Component location drawings

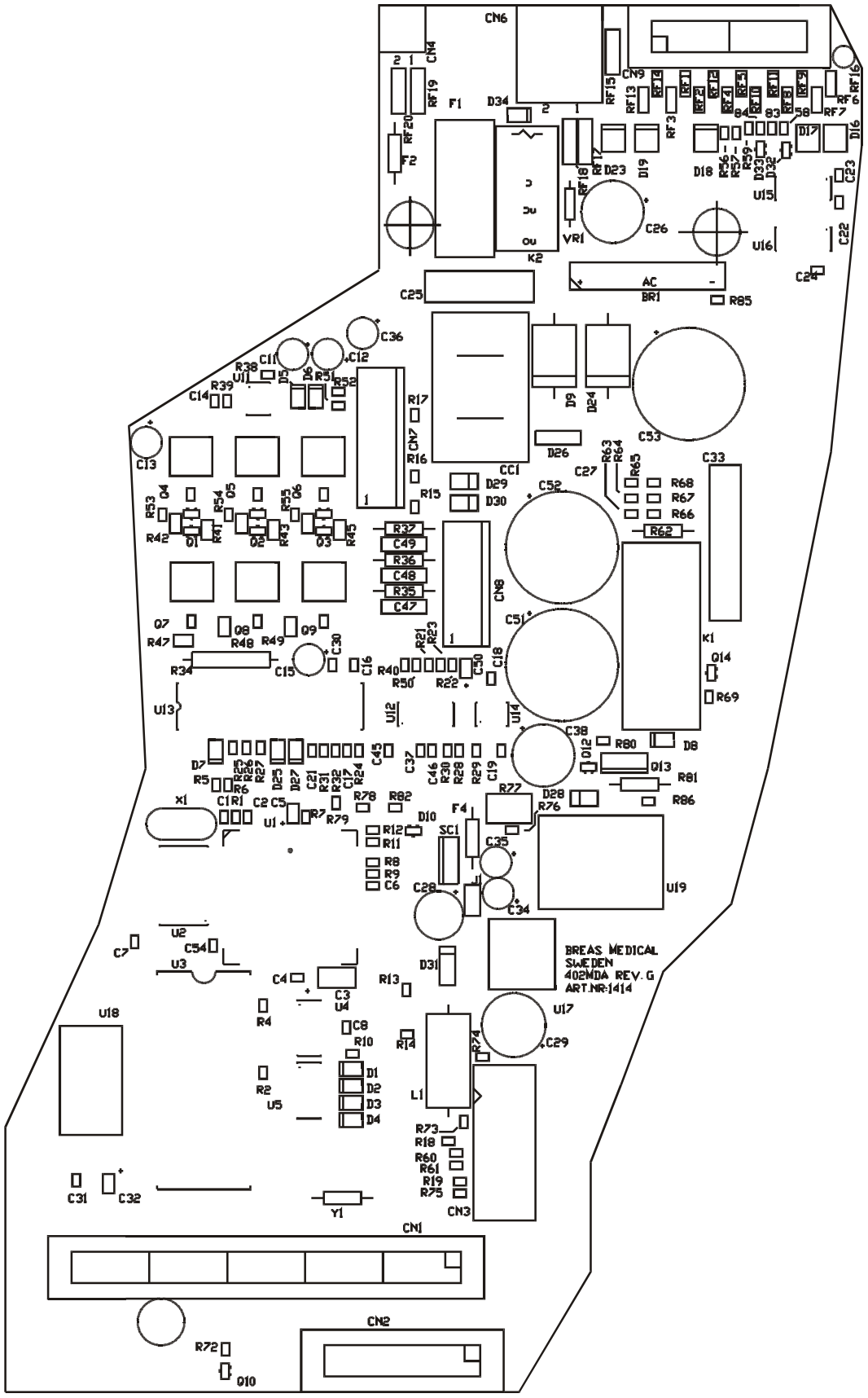
8.14.1 CPU boards

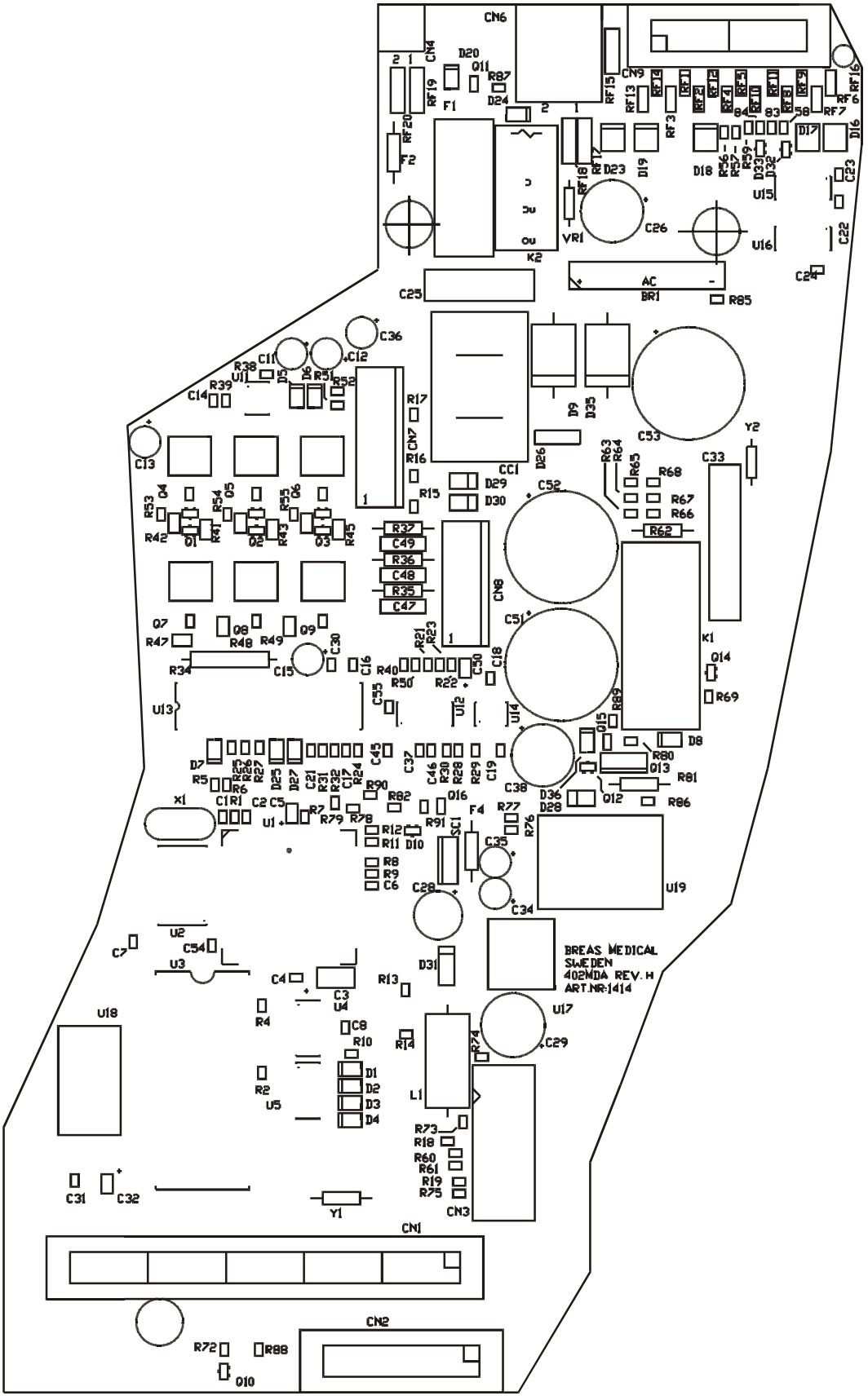



BREAS MEDICAL
402CPU REV.H
ART.NR:1415

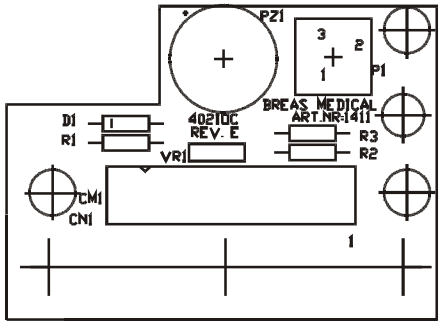
8.14.2 MDA boards



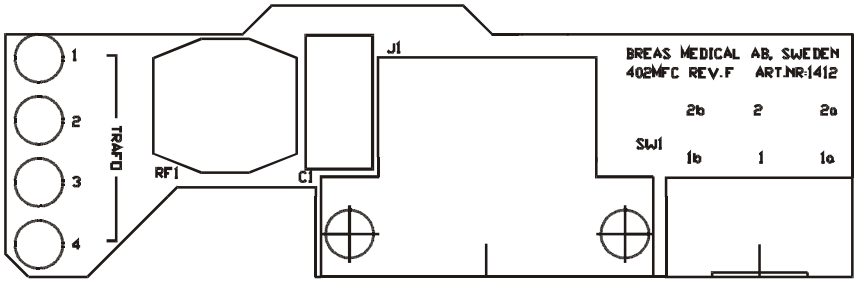

CN6
CN4
F1
F2
K2
VR1
AC
BR1
R85
C36
C12
C11
C14
C13
R17
R16
CN7
CC1
D29
D30
D26
D9
D24
C53
C33
C27
C52
C51
R62
K1
R69
CN8
C49
C48
C47
R37
R36
R35
C30
C15
C16
C18
C50
U13
U12
U14
C38
R80
D8
R81
R86
D28
R76
R77
F4
SC1
C35
C34
U19
BREAS MEDICAL
SWEDEN
402MDA REV. G
ART.NR:1414
U17
C29
U18
U5
L1
R73
R18
R60
R61
R19
R75
CN3
Y1
CN1
CN2
R72
D10
X1
U1
C54
U2
U3
U4
C3
C4
R13
D31
C31
C32
D1
D2
D3
D4


CN6
CN4
D20
Q11
R87
F1
D24
RF19
RF20
F2
CN9
RF15
RF13
RF14
RF1
RF2
RF4
RF5
RF10
RF8
RF9
RF16
RF6
RF7
D16
D17
D18
D19
D23
RF18
RF17
R56
R57
R59
D33
D32
U15
C23
C22
C26
VR1
K2
U16
C24
C25
AC
BR1
R85
C36
C11
C12
R38
U11
D5
D6
R51
R52
C14
R39
R17
CN7
R16
C13
CC1
D9
D35
D26
C53
Y2
C33
R63
R64
R65
R68
R67
R66
R62
D29
D30
R15
C52
R53
R54
R55
Q4
Q5
Q6
R42
R41
R43
R45
Q1
Q2
Q3
R37
C49
R36
C48
R35
C47
CN8
C51
K1
Q14
R69
Q7
Q8
Q9
R47
R48
R49
C30
R34
C15
C16
R40
R50
R22
C50
C18
R21
R23
U13
C55
U12
U14
Q15
R89
D8
R80
Q13
R81
D7
R5
R6
D25
D27
C21
R31
R32
C17
R24
C45
C37
C46
R30
R28
R29
C19
C38
D36
D28
Q12
R86
R90
R82
Q16
X1
C1
R1
C2
C5
U1
R7
R79
R78
R12
R11
D10
R91
SC1
F4
R77
R76
C35
U19
R8
R9
C6
C28
C34
U2
C54
C7
U3
C4
C3
R13
D31
BREAS MEDICAL
SWEDEN
402MDA REV. H
ART.NR-1414
U4
R4
C8
R10
R14
R74
U17
C29
U18
D1
D2
D3
D4
R2
U5
L1
R73
R18
R60
R61
R19
R75
CN3
C31
C32
Y1
CN1
CN2
R72
R88
D10

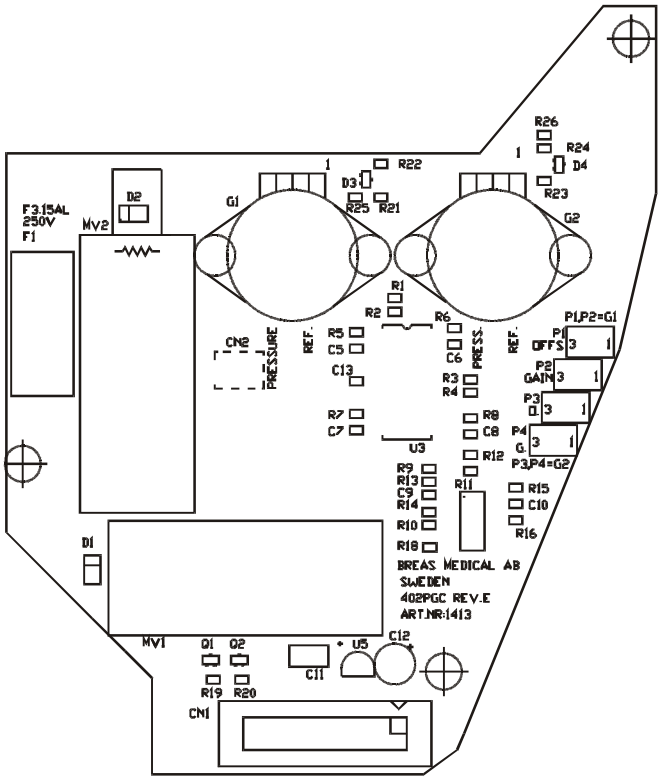
8.14.3 I/O board



8.14.4 MFC



8.14.5 PGC



8.15 List of Components

CPU BOARD, REV L

R1	0 ohm	0805
R2	2k2	0805
R3	10k	0805
R4	2k2	0805
R5	1k	0805
R6	1k	0805
R7	1k	0805
R8	1k	0805
R9	1k	0805
R10	3M9	0805
R11	1k	0805
R12	10k	0805
R13	10k	0805
R14	15k	0805
R15	1k	0805
R16	10k	0805
R17	10k	0805
R18	470	0805
R19	470	0805
R20	470	0805
R21	470	0805
R22	470	0805
R23	10k	0805
R24	10k	0805
R25	10k	0805
R26	10k	0805
R27	10k	0805
R28	100	0805
R29	10k	0805
R30	3M9	0805
R31	1k	0805
R32	1k	0805
R33	1k	0805
R34	1k	0805
R35	1k	0805
R36	1k	0805
R37	1k	0805
R38	1k	0805
R39	1k	0805
R40	1k	0805
R41	1k	0805
R42	1k	0805
R43	1k	0805
R44	1k	0805
R45	1k	0805
R46	1k	0805
R47	330	0805
R48	330	0805
R49	10k	0805
R50	10k	0805

R51	2k2	0805
R52	47/4W	12 MOD AXIAL
R53	2k2	0805
R54	56k	0805
R55	3M9	0805
R56	470	0805
R57	100k	0805
R58	100k	0805
R59	100k	0805
R60	2k2	0805
R61	10k	0805
R62	3E3	0805
R63	3E3	0805
R64	3E3	0805
R65	10k	0805
R66	10k	0805
R67	10k	0805
R68	1k	1206
R69	10k	0805
R70	10k	0805
R71	10k	0805
R72	10k	0805
R73	10k	0805
R74	10k	0805
R75	10k	0805
R76	1k	0805
R77	100	0805
R78	100	0805
R79	100	0805
R80	100	0805
R81	100	0805
R82	100	0805
R83	100	0805
R84	100	0805
R85	1k	0805
R86	1k	0805
R87	10k	0805
R88	10k	0805
R89	10k	0805
B1	0 ohm	0805
P1	10k/1-TURN	BECKMAN 72P
C1	15p/50	0805
C2	15p/50	0805
C3	10u/16	6032
C4	10n/50	0805
C5	1u/20	3216
C6	u1/50	0805
C7	u1/50	0805
C8	u1/50	0805
C9	u1/50	0805
C10	*	
C11	u1/50	0805

C12	*	
C13	u1/50	0805
C14	u1/50	0805
C15	1u/20	3216
C16	u1/50	0805
C17	u1/50	0805
C18	u1/50	0805
C19	u1/50	0805
C20	u1/50	0805 (NO LABEL: PLACED BESIDE R49)
C21	100u/16	1MOD ELLYT
C22	u1/50	0805
C23	*	
C24	u1/50	0805
C25	u1/50	0805
C26	10u/16	6032
C27	10u/16	6032
C28	100u/16	1MOD ELLYT
C29	u1/50	0805
C30	1u/20	3216
C31	10u/16	6032
C32	150p/50	0805
C33	27p/50	0805
C34	10u/16	6032
C35	1u/20	1206
C36	u1/50	0805
C37	u1/50	0805
C38	*	
C39	u1/50	0805
C40	u1/50	0805
C41	1n/50	0805
C42	u1/50	0805
C43	1n/50	0805
C44	1n/50	0805
C45	1n/50	0805
C46	1n/50	0805
C47	1n/50	0805
C48	1n/50	0805
C49	1n/50	0805
C50	u1/50	0805
C51	100u/16	1MOD ELLYT
D1	1N4148	SOD80
D2	1N4148	SOD80
D3	1N4148	SOD80
D4	E562	4MOD AXIAL (ELFANR 70-098-06)
D5	5V6/0.3W	SOT23
D6	1N4148	SOD80
D7	9V1/0.3W	SOT23
D8	*	
D9	*	
D10	*	
D11	BAS85	SOD80

D12	BAS85	SOD80
D13	6V8/0.3W	SOT23
D14	1N4148	SOD80
D15	BAS85	SOD80
D16	BAS85	SOD80
D17	E562	4MOD AXIAL (ELFANR 70-098-06)
SC1	BT148-600R	SOT82
Q1	BC847B	SOT23
Q2	BC847B	SOT23
Q3	BC847B	SOT23
Q4	BC817-40	SOT23
Q5	BC817-40	SOT23
Q6	BC847B	SOT23
Q7	BC808-25	SOT23
Q8	BST82	SOT23
U1	68HC11A1FN	52PLCC
U2	PCF1252-1T	SO8
U3	74HC573	SO20
U4	27C256	DIP28 IN SOCKET
U5	74HC00	SO14
U6	74HC138	SO16
U7	74HC138	SO16
U8	62256	SO28
U9	74HC32	SO14
U10	74HC21	SO14
U11	DS1302	SO8, DALLAS
U12	*	
U13	4066	SO14
U14	74HC574	SO20
U15	74HC574	SO20
U16	74HC541	SO20
U17	REF02	SO8
U18	HD6350/63B50	SO24, HITACHI
U19	74HC164	SO14
U20	74HC164	SO14
U21	74HC164	SO14
U22	74HC164	SO14
U23	*	
U24	ULN2003	SO16
U25	ULN2003	SO16
U26	ULN2003	SO16
U27	ICL7662	DIP8
U28	TL061	SO8
U29	4060	SO16
U30	4040	SO16
U31	4093	SO14
U32	4093	SO14
U33	74HC00	SO14
U34	4027	SO16
U35	*	

U36	4051	SO16
U37	7805	TO220
U38	NC7S32M5	SOT23-5 NATIONAL
X1	4.0MHz	HC49/4H
X2	32.768kHz	RAD 1MOD, GLUED TO PCB
X3	32.768kHz	RAD 1MOD, GLUED TO PCB
NTC1	10k	PHILIPS TYP 640/3977-10k/5%
LC1	32x122-LCD	POWERTIP PG12232-LRS-ANN-B
CN1	40-POL MALE	IDC (ELFANR 43-666-88)
CN2	*	
CN3	50-POL MALE	IDC (ELFANR 43-666-96)
CN4	14-POL MALE	IDC (ELFANR 43-666-39)
RF1	FERRITE ON 50-POL RIBBON CABLE: MATERIAL 43, MIN. WIDTH 13mm	
BT1	4.8V/70mAh	NiMH VARTA 4V70LP1+1S
BT2	3V/950mAh	Lithium VARTA CR 1/2AA SLF

CONNECTORS FOR LC1:20-POL FEMALE STRIP
20-POL MALE STRIP

* COMPONENT DOES NOT EXIST

ELFA REFERENCES TO PARTNUMBER ELFA AB, SWEDEN.

402-1 MDA REV.Q

R1	3M9	0805
R2	1k	0805
R3	*	
R4	1k	0805
R5	1k	0805
R6	1k	0805
R7	1k	0805
R8	10k	0805
R9	10k	0805
R10	4k7	0805
R11	100k	0805
R12	10k	0805
R13	2k2	0805
R14	2k2	0805
R15	100	0805
R16	*	
R17	220	0805
R18	10k	0805
R19	10k	0805
R20	*	
R21	10k	0805
R22	200k	0805
R23	82k	0805
R24	4k7	0805
R25	4k7	0805

R26	4k7	0805
R27	4k7	0805
R28	1k	0805
R29	1k	0805
R30	220	0805
R31	220	0805
R32	220	0805
R33	*	
R34	0.22/3W	7MOD AXIAL (DALE)
R35	1 ohm /1W	4MOD AXIAL
R36	1 ohm /1W	4MOD AXIAL
R37	1 ohm /1W	4MOD AXIAL
R38	10	0805
R39	10k	0805
R40	27k	0805
R41	3k3	1206
R42	3k3	1206
R43	3k3	1206
R44	3k3	1206
R45	3k3	1206
R46	3k3	1206
R47	220	1206
R48	220	1206
R49	220	1206
R50	1k	0805
R51	100k	0805
R52	10k	0805
R53	10	0805
R54	10	0805
R55	10	0805
R56	1k	0805
R57	100	0805
R58	10k	0805
R59	10k	0805
R60	10k	0805
R61	10k	0805
R62	39/1W	4MOD AXIAL
R63	100k	0805
R64	100k	0805
R65	100k	0805
R66	10k	0805
R67	10k	0805
R68	10k	0805
R69	2k2	0805
R70	*	
R71	*	
R72	2k2	0805
R73	10k	0805
R74	10k	0805
R75	10k	0805
R76	220	0805
R77	10k/15-TURN	BECKMAN 64W
R78	10k	0805
R79	1k	0805

R80	10k	0805	
R81	5.6 ohm/1W	4MOD AXIAL	
R82	1k	0805	
R83	10k	0805	
R84	10k	0805	
R85	10k	0805	
R86	10k	0805	
R87	10k	0805	
R88	1k	0805	
R89	10k	0805	
R90	2k2	0805	
R91	1k	0805	
Y1	100ohm/0.6W		4MOD AXIAL
C1	15p/50	0805	
C2	15p/50	0805	
C3	10u/16	6032	
C4	10n/50	0805	
C5	1u/20	1206	
C6	1n/50	0805	
C7	u1/50	0805	
C8	u1/50	0805	
C9	*		
C10	*		
C11	2u2/50	1MOD	ELLYT
C12	4u7/25	1MOD	ELLYT
C13	4u7/25	1MOD	ELLYT
C14	3n3/50	0805	
C15	10u/50	1MOD	ELLYT
C16	u1/50	0805	
C17	10n/50	0805	
C18	*		
C19	u1/50	0805	
C20	*		
C21	10n/50	0805	
C22	u1/50	0805	
C23	u1/50	0805	
C24	u1/50	0805	
C25	u68/63	6MOD	POLY (ELFA 65-231-04)
C26	220/63	2MOD	ELLYT
C27	*		
C28	100/50	2MOD	ELLYT
C29	220/50	2MOD	ELLYT
C30	u1/50	0805	
C31	u1/50	0805	
C32	1u/20	1206	
C33	1u/250	9MOD	POLY MKT
C34	1u/63	1MOD	ELLYT
C35	10u/50	1MOD	ELLYT
C36	4u7/25	1MOD	ELLYT
C37	u1/50	0805	
C38	100u/16	1MOD	ELLYT
C39	3n3/50	0805	

C40	3n3/50	0805	
C41	3n3/50	0805	
C42	3n3/50	0805	
C43	3n3/50	0805	
C44	3n3/50	0805	
C45	u1/50	0805	
C46	u1/50	0805	
C47	22n/63	2MOD	POLY WIMA
C48	22n/63	2MOD	POLY WIMA
C49	22n/63	2MOD	POLY WIMA
C50	1u/20	1206	
C51	2200u/50	3MOD	ELLYT NIPPON-CHEMICON LXV
C52	2200u/50	3MOD	ELLYT NIPPON-CHEMICON LXV
C53	*		
C54	1n/63	0805	
C55	u1/50	0805	
D1	1N4148	SOD80	
D2	1N4148	SOD80	
D3	1N4148	SOD80	
D4	1N4148	SOD80	
D5	1N4148	SOD80	
D6	1N4148	SOD80	
D7	1N4148	SOD80	
D8	1N4148	SOD80	
D9	60S1/6A1	7MOD	DIODE AXIAL
D10	30V/0.3W	SOT23	ZENER
D11	10V/0.3W	SOT23	ZENER
D12	10V/0.3W	SOT23	ZENER
D13	10V/0.3W	SOT23	ZENER
D14	*		
D15	*		
D16	SM6T15CA	TRANZORB	
D17	SM6T15CA	TRANZORB	
D18	SM6T6V8A	TRANZORB	
D19	SM6T6V8A	TRANZORB	
D20	1N4148	SOD80	
D21	*		
D22	*		
D23	SM6T18A	TRANZORB	
D24	1N4148	SOD80	
D25	1N4148	SOD80	
D26	BYV143-F	TO126	
D27	1N4148	SOD80	
D28	SM4004	DIODE	
D29	SM4004	DIODE	
D30	SM4004	DIODE	
D31	BYG90-40	SOD106	
D32	5V6/0.3W	SOT23	ZENER
D33	5V6/0.3W	SOT23	ZENER
D34	*		
D35	60S1/6A1	7MOD	DIODE AXIAL
D36	1N4148	SOD80	

BR1	TS4B07G	RECTIFIER (ELFANR 70-034-78)	
Q1	BC847B	SOT23	
Q2	BC847B	SOT23	
Q3	BC847B	SOT23	
Q4	RFD14N05L	TO252AA	
Q5	RFD14N05L	TO252AA	
Q6	RFD14N05L	TO252AA	
Q7	RFD14N05L	TO252AA	
Q8	RFD14N05L	TO252AA	
Q9	RFD14N05L	TO252AA	
Q10	BC817-40	SOT23	
Q11	BC817/40	SOT23	
Q12	BC857B	SOT23	
Q13	BD136	TO126	
Q14	BC847B	SOT23	
Q15	BC847B	SOT23	
Q16	BC847B	SOT23	
SC1	BT148-600R	SOT82	THYRISTOR
U1	68HC11A1FN		52PLCC
U2	74HC573	SO20	
U3	27C256	DIP28 IN SOCKET	
U4	74HC00	SO14	
U5	74HC393	SO14	
U6	*		
U7	*		
U8	*		
U9	*		
U10	*		
U11	NE555	SO8	
U12	LM324	SO14	
U13	MC33035P	DIP24 0.3"	
U14	MAX522CSA	SO8	
U15	14C88	SO14	
U16	14C89	SO14	
U17	LM2575-12	TO263	
U18	7805	TO220	
U19	LM317T	TO220	
CN1	50-POL MALE		IDC (ELFANR 43-666-96)
CN2	20-POL MALE		IDC (ELFANR 43-666-54)
CN3	14-POL MALE		IDC (ELFANR 43-666-39)
CN4	2-POL MALE	PANDUIT	
CN5	*		
CN6	2-POL TERMINALWAGO		
CN7	9-POL MALE	PANDUIT	
CN8	8-POL MALE	PANDUIT	
CN9	20-POL MALE		IDC (ELFANR 43-666-54)
RF1-RF14	EMIFIL 10nF	MITSUBISHI CNF41	
RF15	EMIFIL 10nF	MURATA DSS306	
RF16	FERRITE	MURATA BL01RN1-A62	

RF17-RF20	EMIFIL 10nF	MURATA DSS306
CC1	2x4.2mH	SCHAFFNER RN214-2/02-4.2mH
K1	SGR282-24VDC	RELAY ELESTA
K2	M4-24H	RELAY MEISEI
VR1	30/38V VARISTOR	SIEMENS S10K30
Y2	60/85V VARISTOR	SIEMENS S10K60
X1	8.0MHz	HC49/4H
L1	330uH/610mA	8MOD AXIAL COIL
F1	FUSE 3.15A SLOW	LITTEL FUSE 2183.15
F2	PICO 3.5A SLOW	LITTEL FUSE 473003.
F3	*	
F4	PICO 125mA FAST	LITTEL FUSE 251.125
J1	JUMPER (SHUNT)	2-PIN
HOLDER TO F1		STELVIO PTF/15

ELFA REFERENCES TO PARTNUMBER ELFA AB, SWEDEN.

401-2 IOC REV.D

R1	47	0.6W 4MOD AXIAL
R2	10k	0.6W 4MOD AXIAL
R3	1k	0.6W 4MOD AXIAL
P1	500 1T TRIM	BECKMAN 72P
D1	4V3	0.5W 4MOD AXIAL
VR1	RXE040	POLYFUSE 2MOD
PZ1	QFP03A	BUZZER STAR MICRONICS
CN1	25-POL FEMALE	DSUB STRAIGHT PC-MOUNT(WITH MIN. 6mm PINS)
CN2	20-POL	TRANSITION CONNECTOR(ELFANR 43-654-33)
RF1	25-SUB FERRITE FOR CN1 (ELFANR 58-738-49)	

401-2 MFC MAINS FILTER CARD REV.C

C1	100n/300	6MOD MKT-X2
RF1	2x10mH/0.8A	RN112-0.8/02 SCHAFFNER
SW1	FUSED INLET	BULGIN PF0030/PC/CLASS-II
F1	FUSE 315mA SLOW	LITTEL FUSE 218.315
F2	FUSE 315mA SLOW	LITTELFUSE 218.315
J1	VOLTAGE SEL.	C&K V802-12-MA-08-Q

FERRITE ON TRANSFORMER PRIMARY: PHILIPS CST19/11/12-3S4 (FARNELL-NR 898-405)

401-2 PGC PRESSURE GAUGE CARD REV.G

R1	39k	0805	
R2	33k	0805	
R3	39k	0805	
R4	33k	0805	
R5	1M	0805	
R6	1M	0805	
R7	1M	0805	
R8	1M	0805	
R9	100k	0805	
R10	100k	0805	
R11	100k	0805	
R12	100k	0805	
R13	100k	0805	
R14	100k	0805	
R15	100k	0805	
R16	100k	0805	
R17	*		
R18	220	0805	
R19	2k2	0805	
R20	2k2	0805	
R21	180	0805	
R22	180	0805	
R23	180	0805	
R24	180	0805	
R25	390	0805	
R26	390	0805	
P1	50k/15-TURN		BECKMAN 64W
P2	20k/15-TURN		BECKMAN 64W
P3	50k/15-TURN		BECKMAN 64W
P4	20k/15-TURN		BECKMAN 64W
C1-C4	*		
C5	1n/40	0805 CER	
C6	1n/40	0805 CER	
C7	1n/40	0805 CER	
C8	1n/40	0805 CER	
C9	15p/40	0805 CER	
C10	15p/40	0805 CER	
C11	10u/16	6032 TANTAL	
C12	1u/50	1MOD ELLYT	
C13	u1/50	0805 CER	
D1	SM4004	DIODE	
D2	SM4004	DIODE	
D3	5V6/0.3W	SOT23	
D4	5V6/0.3W	SOT23	
Q1	BC847B	SOT23	
Q2	BC847B	SOT23	
U1-U2	*		

U3	LM224	DIP14 CERAMIC
U4	LM324	SO14
U5	78L09	TO92
G1	MPX10DP	PRESSURE GAUGE MOTOROLA
G2	MPX10DP	PRESSURE GAUGE MOTOROLA
CN1	20-POL MALE	IDC STRAIGHT
CN2	2-POL PLINT	PHOENIX MPT-0.5/2-2.54
MV1,MV2	MAGNETVALVE	PNEUTRONICS 1094 OHM
F1	FUSE 3.15A SLOW	LITTELFUSE 2183.15
HOLDER FOR F1		STELVIO PTF/15

9 FAULT TRACING

9.1 Fault tracing scheme

Symptom	Possible cause	Remedial action	See Ch.
LED for “POWER” is on and the ventilator alarms at start-up.	The power cord is not properly connected.	Connect the power cord.	2
	Measure the voltage across pins in connector CN6 (MDA board). Voltage should be 24 VAC	If there is voltage, replace the MDA board, or If there is no voltage, check the filter board and transformer.	8
	Mains fuse blown.	Replace the fuse.	2
Will not run from external battery supply.	External batteries are discharged.	Charge the batteries	2
	External battery cable is not connected properly or is faulty.	Connect the cable / measure and replace if faulty.	2
	External battery fuse on the MDA board has blown.	Replace the fuse.	2
	If the fuse blows immediately after connecting the external battery cable.	Check the polarity.	2
	With the battery connected, measure the voltage between the pins in CN6. It should be approx. 24 VDC.	If the voltage is OK, replace the MDA board. If there is no voltage, check the wiring and filter board. Replace if faulty.	8
The ventilator does not give adequate pressure/volume.	Leakage from patient circuit/ mask.	Check the tubes, mask and exhalation valve for leakage.	2
	Internal leakage from tubes, bellows or check valves.	Perform a leakage test.	8
	Filters dirty.	Replace white filter, wash grey filters.	2
Pressure indicator shows no pressure reading.	Internal supply tube blocked.	Check the tubes and connectors.	5
	MDA board faulty.	Check by connecting a voltmeter to the pressure outlet on the rear panel if a change in pressure causes a change in the voltage. P = 0 cm H_2O gives 1V P = 30 cm H_2O gives 4V If not, replace the CPU board.	8
	Pushbutton panel faulty.	Replace pushbutton panel.	6

9.2 Error codes

The PV 401-2 contains an Error Code memory which can store the last 20 error codes generated. These codes provide useful information when fault-finding or carrying out service work. To read the error codes, proceed as follows:

- Press and hold the minus button.
- Start the ventilator, keeping the minus button pressed.
- The display will now show the message FAIL MEM. PUSH FUNC TO SHOW
- Press the Function button.
- The latest error code stored is shown first. The information given is YEAR, MONTH, DAY, HOUR, MINUTE, the text FAIL and the error code itself (see below for explanations).
- Press the Function button to page back through the error codes to the earliest code stored.
- After the last code has been displayed, the message: SHOW FAIL RDY is shown. Switch the ventilator off.

9.3 List of error codes

The table shows each error code, the explanation of what it means and the action required to correct the problem. Where there is more than one action listed, these are listed in the order they should be performed e.g. if action1 does not solve the problem then continue with action 2, and so on.

See Chapter 6 for information about replacing circuit boards, etc.

,

Error code	Explanation	Action required
00	Slave processor does not respond.	1 Replace the ribbon cable between the MDA boards. 2 Replace the MDA board. 3 Replace the CPU board.
01	Start of bellows movement failed.	1 Let the ventilator warm up if cold. 2 Replace the motor/motor unit. 3 Replace the MDA board.
02	Slave processor failed to respond.	1 Replace the ribbon cable between the MDA boards. 2 Replace the MDA board. 3 Replace the CPU board.
03	Bellows does not move.	1 Let the ventilator warm up if cold. 2 Replace the motor/motor unit. 3 Replace the MDA board.
04	Master EEPROM error.	Replace CPU board.
05	Master processor RAM error.	Replace CPU board.
06	Master processor program error.	Replace CPU board.
07	Master processor error.	Replace CPU board.

Error code	Explanation	Action required
08	Alarm battery low.	1 Connect to mains for charging. 2 Replace the MDA board.
09	Counter error - motor encoder.	1 Replace motor/motor unit. 2 Replace the MDA board.
10	Master processor program IC error.	Replace CPU board.
11	Mains power supply low.	If mains current is OK, replace MDA board.
31	Pressure convertor/amplifier #1 error.	Replace CPU board.
32	Pressure convertor/amplifier #2 error.	Replace CPU board.
33	Motor stopped. Signal path diode D25 error.	Replace MDA board.
34	Motor stopped. Signal path D27 error.	Replace MDA board.
35	Slave processor RAM error.	1 Replace slave processor. 2 Replace the MDA board.
36	Slave processor error.	1 Replace slave processor. 2 Replace the MDA board.
37	Master processor measurement error.	Replace CPU board.
38	D/A convertor error.	Replace MDA board.
39	Pressure convertor/amplifier error.	1 Check internal/external tubes and hoses. 2 Replace the CPU board.
40	External battery, low voltage.	Charge/replace external battery.
41	Pressure, measurement error.	1 Check internal/external tubes and hoses. 2 Replace the CPU board.
42	PC communication IC (U12) error.	1 Replace the CPU board. 2 Replace the MDA board.
44	Coomunication error at serial port.	Check connector on serial cable.
45	MDA charger.	Replace the MDA board.
46	MDA Boost DC.	Replace the MDA board.
47	Ext 12V to remote.	1 Disconnect any cable connected to the D-sob connector. 2 Replace the I/O board. 3 Replace the MDA board.
51	NV time does not match.	Replace CPU board.
52	NV store pointer does not match.	Replace CPU board.
53	NV store pointer points below NVRAM.	Replace CPU board.

Error code	Explanation	Action required
54	NV store 10-bit converter counter does not match.	Replace CPU board.
55	NV read 10-BIT converter counter dpes not match.	Replace CPU board.
56	Calender pointer does not match.	Replace CPU board.
57	NO NVRAM MOUNTED	Replace CPU board.
58	Both EE hour values corrupted.	Replace CPU board.

10.1 ENGINEERING CHANGE HISTORY PV 401-2

From serial No.	Change made
K48	Software upgrade Master MAQ, Slave SAD. Audible alarm is given when switching from mains power to external battery power if no internal battery is installed. At start-up operating time is shown in the display for 4 seconds.
K48207	Motor unit Rev. B.
November 1998	Software upgrade Master MAR, Slave SAD. Audible alarm is given for one second when switching from mains power to external battery.
M03000	MDA Rev. F. CPU Rev. G. Plastic pins for LCD display.
M05043	Software upgrade Master MAS, Slave SAD. Logging of low battery. Internal/External battery relay. Remote protocol. Bar diagram reading slower.
M07051	Software upgrade Master MAT, Slave SAD. Monitoring of low internal battery level.
M09000	Software upgrade Master MAW, Slave SAD. Setup menu for installation of internal battery. MDA Rev. G2. Relay K2 internal/external battery.
M19000	Software upgrade Master MAX.

Service Record for Breas PV 401-2

Service Record No:_____

Registration

Model:..... Serial No...... Inventory No. .....

Accessories: .....

Delivery date:..... No. of operating hours: .....

Service started:..... Signature: .....

Service completed:..... Signature: .....

Delivered, date: ..... Signature: .....

General	**Read instruction No.**	**Check OK**
Open new service record, Identify the ventilator	3.6.1	.....
Note number of operating hours	3.6.2	.....
Check all markings	3.6.3	.....
Information from user	3.6.4	.....
Validity of documentation	3.6.5	.....
External checks		
Inspect for external damage and wear	3.7.1	.....
Check power connection	3.7.2	.....
Perform minimum function check	3.7.3	.....
Internal checks		
Clean inside ventilator	3.8.1	.....
Check cabling	3.8.2	.....
Check fastening of components	3.8.3	.....
Motor Unit		
Check if motor unit is to be replaced, 20,000 hrs	6.10	.....
Replace the drive belt	7.3	.....
Lubricate ball screw	7.4	.....
Replace the membranes in both check valves	7.5	.....
Electronics		
Power supply	3.8.7	.....
Calibrate the pressure sensor	8.5	.....
Check if alarm batteries need to be replaced	8.8	.....
After reassembly		
Check electrical safety levels	8.11	.....
Leakage test of motor unit and tubes	7.6	.....
Final checks before handing over		
Function check	3.9.1	.....
Check low pressure/leakage alarm	3.9.2	.....
Check low volume alarm	3.9.3	.....
Check alarm mute	3.9.4	.....
Check trigger function	3.9.5	.....
Check pressure/rate	3.9.6	.....
Check tidal volume indication	3.9.7	.....
Check internal battery operation	3.9.8	.....
Check external battery operation	3.9.9	.....
Check accessories (where applicable)	3.9.10	.....
Replace/wash patient filters	3.9.11	.....
Adjust correct setting for patient	3.9.12	.....

Turn for comments and notes

Notes

10.3 RETURNING PRODUCTS TO BREAS

If a product needs to be returned to Breas for any reason, e.g. for service, warranty, repair or upgrade, the following routine must be followed to ensure that the correct action is taken and to avoid unnecessary delays.

Pack the product in its original packaging. If this is not available, pack the product in packaging suitable for the transportation to Breas.

Note! Damage caused by poor packaging or during transportation is NOT covered by the factory warranty.

Fill out the Customer part of a Service Report and pack it together with the product. The Service Report, completed by Breas, will be returned with the product.

A copy of the Service Report is provided on the next page. This can be photocopied and used as required.

Service Report

Breas Ref. No: _____

Customer Name & Address: .....

.....

Reference:..... Ref. No. .....

Model: ..... Serial No:..... Running time.....h

Error /Complaint / Accessories

.....

.....

.....

Date received by BREAS:..... Signature.....

Repair ☐ **Warranty** ☐ **Update** ☐ **Charge** ☐ **Other** ☐

Action taken:

_____

_____

_____

_____

_____

_____

_____

Parts used: **Pcs:** **Price:**

_____

_____

_____

_____

Running hours from BREAS:_____h

Date returned to customer: _____ Signature:_____

Use reverse side for notes etc.

Notes